

**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)**

**Fourteenth Meeting**  
25–26 February 2021 (Online)

**UNESCO**

**Intergovernmental Oceanographic Commission**  
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## *Executive Summary*

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The Fourteenth Meeting of the Working Group on Tsunamis and Other Hazards related to Sea-Level Warning and Mitigation Systems (TOWS-WG-XIV) was held online, on 25–26 February 2021, under the Chairship of Mr Alexander Frolov (IOC Vice-Chair). The meeting evaluated the progress made in respect to the decision [IOC-XXX/8.2](#) of the IOC Assembly at its 30<sup>th</sup> session (26 June–4 July 2019, Paris).

**The Group confirmed** that the UN Decade of Ocean Science for Sustainable Development (the Ocean Decade) provides a once-in-a-generation opportunity to address and potentially fill capability gaps by leveraging novel sensing platforms, techniques and/or infrastructure in order to more quickly detect, measure, forecast and warn for tsunamis, even from the near-instant they form, and to enhance the preparedness of coastal communities for tsunamis through the UNESCO/IOC Tsunami Ready Programme.

**The Group endorsed** the document “*Protecting Communities from the World’s Most Dangerous Waves: A Framework for Action under the UN Decade of Ocean Science for Sustainable Development*” (annex 1 to [Circular Letter, 2825](#)) as a guiding document to develop a Draft 10-Year Research and Development and Implementation Plan that will be registered as an Ocean Decade Action called the *Ocean Decade Tsunami Programme (the programme)* **and recommended** a governance structure for *the programme*.

**The Group also recommended** that the Draft 10-Year Research, Development and Implementation Plan for the *Ocean Decade Tsunami Programme (the programme)* is dedicated to achieving transformational advances in tsunami detection, measurement and forecasting, including tsunamis generated by non-seismic sources. **The Group recommended** that *the programme* include the following focus areas related to tsunami warning capabilities:

1. Expansion of existing observational systems including seismometers, coastal tide gauges, and deep ocean tsunameters to fill identified gaps;
2. Deploy new technologies to address observational gaps that cannot be covered by existing networks. This would include the widespread implementation of scientific instrumentation on deep-ocean telecommunications cables as developed by the ITU/WMO/UNESCO-IOC Joint Task Force (JTF) SMART Subsea Cables effort and submitted as a Programme to the UN Decade of Ocean Science for Sustainable Development;
3. Wide expansion of data access and availability and development of capability for real-time and near-real time sea level, seismic and GNSS-derived land motion data at an appropriate sampling rate and relevant tools to forecast tsunamis from all sources;
4. Increase access and regularly update the collection of coastal topographic and bathymetric data, in collaboration with the Nippon Foundation-GEBCO Seabed 2030 project, as well as high performance computational capabilities to enable more timely, accurate and comprehensive tsunami and other coastal hazard forecasts to better advise community response;
5. Ensure all National Tsunami Warning Centres have access to data, tools and communication platforms, protocols and training to timely and effectively warn coastal and maritime communities threatened by tsunamis and other coastal hazards and are integrated into a multi hazard framework.

**The Group further recommended** that the Draft 10-Year Research, Development and Implementation Plan for the *Ocean Decade Tsunami Programme (the programme)* contribute to achieving the societal outcome of “A Safe Ocean” 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 Programme and other initiatives to include, but not limited to:

1. The adoption and continued implementation of the UNESCO/IOC Tsunami Ready Guidelines and Indicators as the international standard for evidence-based community preparedness for tsunamis;
2. Enhanced access and capacity development for high-resolution near shore bathymetric and topographic data and identification of potential tsunami sources for accurate and improved inundation modelling and evacuation mapping and planning in support of Tsunami Ready communities;
3. Enhanced integration to minimize tsunami disaster impacts and to enable rapid restoration of socio-economic activities and critical infrastructure services post tsunami impacts.

**The Group requested** that the IOC Assembly at its 31<sup>st</sup> session in 2021 consider approving the establishment of the Ocean Decade Tsunami Programme and the Scientific Committee to prepare the Draft 10-Year Research, Development and Implementation Plan for *the programme* with Terms of Reference included in [Appendix 1](#) of Annex II to this report.

**The Group recommended** to the IOC Assembly at its session in 2021 to encourage Member States to provide voluntary financial loans to IOC special accounts and in-kind contribution to support the Ocean Decade Tsunami Programme;

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

- The Caribe Wave 20, PacWave20, and IOWave20 exercises which took place in 2020 despite the COVID-19 pandemic;
- The UNDRR-IOC 2020 campaign consisting of high-level events, regional webinars, social media visuals, videos, and eyewitness accounts, as well as the creation of 15 videos highlighting countries joining the global Tsunami Ready community;
- The growing interest and excellent progress by Member States in all Intergovernmental Coordination Groups of regional tsunami warning systems in piloting UNESCO/IOC Tsunami Ready;
- The progress reported by Indonesia on their application for ISO certification of a Community Based Early Warning System;
- The opportunity to leverage new capabilities such as SMART (Scientific Monitoring and Reliable Telecommunications) cable systems, and GNSS-based land deformation data in order to improve tsunami detection, measurement and forecasts particularly in under-observed areas;
- The potential availability of large volumes of topographic and bathymetric data through the Nippon Foundation/General Bathymetric Chart of the Oceans (GEBCO) Seabed 2030 initiative that are essential for producing more accurate and timely tsunami forecasts to all coastal communities.

**The Group recommended** to the IOC Assembly at its 31<sup>st</sup> session in 2021 to encourage Member States to:

- Use best practices in engineering design and construction of evacuation shelters, especially where local tsunami hazards exist;
- Include the Indian Ocean Tsunami Information Center (IOTIC) compilation of school Disaster Risk Reduction and preparedness materials as a resource, and especially as part of Tsunami Ready pilots that include schools.

**The Group recommended** the IOC Assembly at its session in 2021 to instruct the regional Intergovernmental Coordination Groups to:

- Continue the strong collaboration between the IOC and UNDRR for the 2021 World Tsunami Awareness Day, noting that on November 5 this year, WTAD will highlight Target F of the Sendai Framework on international cooperation to developing countries through support to the implementation of their national and local strategies for disaster risk reduction;
- Urgently complete the Tsunami Ready Guidelines (IOC Manuals and Guides, 74) for widespread distribution to Member States;
- Include local source tsunami Standard Operating Procedures as an important component of the UNESCO/IOC Tsunami Ready programme;
- Develop standardized trainings that can be delivered online or in person, in particular through the Ocean Teacher Global Academy (OTGA).

**The Group requested** the Secretariat to:

- Organize a virtual meeting on WAVE exercises and coordinate it so as to minimize date conflicts and share best practices for exercise evaluation and the use of online tools;
- Arrange a virtual meeting of the TOWS-WG Task Team on Disaster Management & Preparedness (TT DMP) on key performance indicators (KPIs) in the near future to discuss a work plan for harmonizing performance monitoring frameworks across all the Intergovernmental Coordination Groups (ICGs), that include KPIs for integrating international cooperation into the KPIs of CARIBE-EWS, IOTWMS, and NEAMTWS.

**The Group accepted** the reports from the Task Teams on Disaster Management & Preparedness, and 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 recommended** that the IOC Assembly at its 31<sup>st</sup> session in 2021 take the following action:

- To extend the tenure of the Working Group on Tsunamis and Other Hazards related to Sea-Level Warning and Mitigation Systems and its Task Teams on: (i) Disaster Management & Preparedness (TT DMP), and (ii) Tsunami Watch Operations (TT TWO), with terms of reference as given in [IOC Resolution XXIV-14](#) [for TOWS-WG], report [IOC/TOWS-WG-VI/3, Annex II](#) [for TT DMP] and report [IOC/TOWS-WG-X/3, Annex II \(Appendix 1\)](#) [for TT TWO].



## Résumé exécutif

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La 14<sup>e</sup> 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-XIV) s'est tenue en ligne les 25 et 26 février 2021, 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-XXX/8.2](#) adoptée par l'Assemblée de la COI à sa 30<sup>e</sup> session (26 juin – 4 juillet 2019, Paris).

**Le Groupe a confirmé** que la Décennie des Nations Unies pour les sciences océaniques au service du développement durable (la Décennie de l'Océan) offrira une occasion unique de combler les lacunes en matière de capacités en tirant parti de plates-formes, de techniques et/ou d'infrastructures de détection novatrices afin de détecter, de mesurer et de prévoir plus rapidement les tsunamis, et d'alerter plus précocement les populations, dès l'instant où ils se forment, ainsi que d'améliorer la préparation des communautés côtières en cas de tsunami grâce au programme UNESCO/COI Tsunami Ready.

**Le Groupe a approuvé** le document « Protéger les communautés contre les vagues les plus dangereuses au monde : un cadre d'action pour la Décennie des Nations Unies pour les sciences océaniques au service du développement durable » (annexe 1 de la [Lettre circulaire n° 2825](#)), un document d'orientation permettant d'élaborer un projet de plan décennal de recherche, de développement et de mise en œuvre, qui sera enregistré en tant qu'action de la Décennie de l'Océan intitulée *Programme relatif aux tsunamis de la Décennie de l'Océan (le Programme)*, **et a recommandé** qu'une structure de gouvernance soit établie pour ce programme.

**Le Groupe a également recommandé** que le projet de plan décennal de recherche, de développement et de mise en œuvre concernant le Programme relatif aux tsunamis de la Décennie de l'Océan (le programme) vise essentiellement à réaliser des avancées décisives en matière de détection, de mesure et de prévision des tsunamis, y compris les tsunamis générés par des sources non sismiques. **Le Groupe a recommandé** que *le programme* porte sur les domaines d'intérêt suivants en matière de capacités d'alerte aux tsunamis :

1. étendre les systèmes d'observation en place, notamment les sismomètres, les marégraphes côtiers et les tsunamimètres en eaux profondes, afin de combler les manques identifiés;
2. déployer de nouvelles technologies permettant de combler les faiblesses en matière d'observation que les réseaux existants ne sont pas en mesure de couvrir. Il s'agirait notamment de généraliser l'implantation d'instruments scientifiques sur les câbles de télécommunications en eaux profondes, comme le prévoit l'initiative relative aux câbles sous-marins (SMART) du Groupe d'action mixte UIT-OMM-COI-UNESCO, soumise en tant que Programme au titre de la Décennie des Nations Unies pour les sciences océaniques au service du développement durable ;
3. favoriser largement l'accès aux données et leur disponibilité, ainsi que la capacité de fournir en temps réel ou quasi réel des données marégraphiques, sismiques et des données de déformation de la surface terrestre obtenues via le GNSS, à un taux d'échantillonnage approprié, ainsi que des outils pertinents pour prévoir les tsunamis de toutes origines ;
4. élargir l'accès à un ensemble de données topographiques et bathymétriques côtières, et les actualiser régulièrement, en collaboration avec le projet Seabed 2030 de la Nippon Foundation-GEBCO, et également améliorer les capacités de calcul à haute performance pour permettre des prévisions plus rapides, plus précises et plus complètes en ce qui concerne les tsunamis et autres risques côtiers, de façon à mieux prévenir les communautés quant aux mesures à prendre à cet égard ;

5. veiller à ce que tous les centres nationaux d'alerte aux tsunamis aient accès aux données, aux outils et aux plates-formes de communication, aux protocoles et à la formation afin d'alerter efficacement et rapidement les communautés côtières et maritimes menacées par les tsunamis et d'autres risques côtiers, et à ce qu'ils soient intégrés dans un cadre multirisques.

**Le Groupe a en outre recommandé** que le projet de plan décennal de recherche, de développement et de mise en œuvre concernant le *Programme relatif aux tsunamis de la Décennie de l'Océan (le programme)* contribue à la réalisation du résultat sociétal « Des océans sûrs », de façon à ce que 100 % des communautés exposées aux tsunamis soient préparées et résilientes face à ce risque d'ici à 2030, grâce à la mise en œuvre du Programme Tsunami Ready de l'UNESCO/COI et d'autres initiatives, parmi lesquelles, entre autres :

1. l'adoption et la mise en œuvre des lignes directrices et des indicateurs « Tsunami Ready » de l'UNESCO/COI, qui constituent une norme internationale permettant d'établir le niveau de préparation des communautés aux tsunamis sur des données factuelles ;
2. l'amélioration de l'accès aux données bathymétriques et topographiques côtières à haute résolution et du développement des capacités en la matière, ainsi que le recensement des sources potentielles de tsunamis afin de permettre une modélisation précise et améliorée des inondations et d'établir une cartographie des voies d'évacuation et la planification de l'évacuation à l'intention des communautés Tsunami Ready ;
3. une intégration renforcée visant à limiter au maximum les conséquences des tsunamis et à permettre la reprise rapide des activités socioéconomiques et des services liés aux infrastructures essentielles après un tsunami.

**Le Groupe a demandé** que l'Assemblée de la COI, à sa 31<sup>e</sup> session en 2021, envisage d'approuver l'établissement du Programme relatif aux tsunamis de la Décennie de l'Océan et que le Comité scientifique élabore le projet de plan décennal de recherche, de développement et de mise en œuvre de ce programme, selon le mandat qui figure à l'appendice 1 de l'annexe II du présent rapport.

**Le Groupe a recommandé** que l'Assemblée de la COI, à sa session de 2021, encourage les États membres à accorder des prêts financiers volontaires au profit des comptes spéciaux de la COI ainsi que des contributions en nature à l'appui du Programme relatif aux tsunamis de la Décennie.

**Le Groupe a pris note** avec satisfaction des progrès accomplis au cours de la période intersessions, notamment :

- les exercices Caribe Wave 20, PacWave20 et IOWave20 qui se sont déroulés en 2020 malgré la pandémie de COVID-19 ;
- la campagne UNDRR-COI 2020, qui a donné lieu à des événements de haut niveau, des webinaires régionaux, des visuels pour les médias sociaux, des vidéos et des récits de témoins oculaires, ainsi qu'à la création de 15 vidéos mettant en lumière les pays ayant rejoint la communauté mondiale Tsunami Ready ;
- l'intérêt croissant des États membres et les excellents progrès qu'ils ont réalisés dans tous les groupes intergouvernementaux de coordination des systèmes régionaux d'alerte aux tsunamis pour piloter le programme Tsunami Ready de l'UNESCO/COI ;

- les progrès annoncés par l'Indonésie concernant sa demande de certification ISO d'un système d'alerte rapide à destination des communautés ;
- la possibilité de tirer parti de nouvelles capacités telles que les systèmes de câbles SMART (Scientific Monitoring and Reliable Telecommunications – Surveillance scientifique et télécommunications fiables) et les données de déformation de la surface terrestre exploitant le réseau GNSS, afin d'améliorer la détection, la mesure et la prévision des tsunamis, en particulier dans les régions sous-équipées ;
- la disponibilité potentielle de grands volumes de données topographiques et bathymétriques grâce à l'initiative « Seabed 2030 » de la Fondation nippone/Carte générale bathymétrique des océans (GEBCO), qui sont essentielles pour fournir des prévisions plus précises et plus rapides des tsunamis à toutes les communautés côtières.

**Le Groupe a recommandé** que l'Assemblée de la COI, à sa 31<sup>e</sup> session en 2021, encourage les États membres à :

- adopter les meilleures pratiques en matière de conception technique et de construction d'abris d'évacuation, en particulier là où il existe des risques de tsunamis d'origine locale ;
- utiliser la compilation des matériels scolaires de réduction des risques de catastrophe et de préparation aux catastrophes du Centre d'information sur les tsunamis dans l'océan Indien (IOTIC), en particulier dans le cadre des initiatives pilotes Tsunami Ready qui incluent des écoles.

**Le Groupe a recommandé** que l'Assemblée de la COI, à sa 31<sup>e</sup> session en 2021, donne instruction aux groupes intergouvernementaux de coordination :

- de maintenir l'étroite collaboration entre la COI et le Bureau des Nations Unies pour la prévention des catastrophes (UNDRR) en vue de la Journée mondiale de sensibilisation aux tsunamis 2021, notant que le 5 novembre de cette année, la Journée mettra en lumière l'objectif F du Cadre de Sendai visant à améliorer la coopération internationale avec les pays en développement par un appui à la mise en œuvre de leurs stratégies nationales et locales de réduction des risques de catastrophe ;
- d'achever sans délai l'élaboration des principes directeurs sur la préparation aux tsunamis Tsunami Ready (Manuels et guides de la COI, n° 74) afin de les diffuser largement auprès des États membres ;
- d'inclure les procédures opérationnelles normalisées relatives aux tsunamis d'origine locale en tant que composante importante du programme pilote Tsunami Ready de l'UNESCO/COI ;
- d'élaborer des formations standardisées pouvant être dispensées en ligne ou présentiel, en particulier par le biais de l'Académie mondiale OceanTeacher.

**Le Groupe a demandé** au Secrétariat :

- d'organiser une réunion virtuelle sur les exercices WAVE et de la coordonner de manière à limiter les conflits de calendrier et à partager les meilleures pratiques concernant l'évaluation des exercices et l'utilisation des outils en ligne ;
- d'organiser dans un avenir proche une réunion virtuelle de l'Équipe spéciale du TOWS-WG sur la gestion et la préparation en cas de catastrophe (TT DMP) sur les indicateurs de performance clés pour discuter d'un plan de travail pour l'harmonisation des cadres de

suivi des performances de tous les groupes intergouvernementaux de coordination (GIC), qui comprennent des indicateurs de performance clés visant à intégrer la coopération internationale dans les indicateurs du CARIBE-EWS, de l'IOTWMS et du NEAMTWS.

**Le Groupe a approuvé** les rapports soumis par les équipes spéciales sur la gestion et la préparation en cas de catastrophe et sur les opérations d'alerte aux tsunamis, et leur a **donné instruction** de poursuivre leurs efforts pour acquérir des connaissances sur les méthodes de surveillance et d'intervention pour les tsunamis générés par des sources non sismiques ainsi que leurs efforts en vue de leur possible intégration dans les systèmes opérationnels d'alerte aux tsunamis.

**Le Groupe a recommandé** que l'Assemblée de la COI, à sa 31<sup>e</sup> session en 2021, prenne les mesures suivantes :

- prolonger les fonctions 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) et de ses équipes spéciales sur (i) la gestion et la préparation en cas de catastrophe (TT DMP) et (ii) les opérations d'alerte aux tsunamis (TT TWO), selon les mandats respectivement définis dans la [résolution IOC-XXIV-14](#), à l'[annexe II du document IOC/TOWS-WG-VI/3](#), et à l'[annexe II \(appendice 1\) du document IOC/TOWS-WG-X/3](#).

### *Resumen ejecutivo*

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La 14ª 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-XIV) se celebró en línea los días 25 y 26 de febrero de 2021, 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-XXX/8.2](#), adoptada por la Asamblea de la COI en su 30ª reunión (París, 26 de junio-4 de julio de 2019).

**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 única para abordar y posiblemente colmar los déficits de capacidad mediante el aprovechamiento de nuevas plataformas, técnicas o infraestructuras de detección, con el fin incrementar la rapidez de la detección, la medición, la previsión y la alerta en relación con los tsunamis, incluso prácticamente desde el instante en que se forman, y de mejorar la preparación de las comunidades costeras frente a los tsunamis a través del programa Tsunami Ready de la COI/UNESCO.

**El Grupo respaldó** el documento “Protecting Communities from the World’s Most Dangerous Waves: A Framework for Action under the UN Decade of Ocean Science for Sustainable Development” (“Proteger a las comunidades de las olas más peligrosas del mundo: un marco de acción en el contexto del Decenio de las Naciones Unidas de las Ciencias Oceánicas para el Desarrollo Sostenible”) (anexo 1 de la [circular 2825](#) de la COI) como documento de orientación para elaborar un proyecto de plan decenal de investigación, desarrollo y ejecución que se registrará como una iniciativa del Decenio del Océano denominada “Programa del Decenio del Océano sobre los Tsunamis”, y **recomendó** una estructura de gobernanza para dicho Programa.

**El Grupo recomendó también** que el proyecto de plan decenal de investigación, desarrollo y ejecución del Programa del Decenio del Océano sobre los Tsunamis se centrara en lograr avances transformadores en materia de detección, medición y previsión de tsunamis, incluidos los tsunamis generados por fuentes no sísmicas. **El Grupo recomendó además** que el Programa mencionado incluyera los siguientes ámbitos prioritarios en relación con las capacidades de alerta contra los tsunamis:

1. Ampliación de los sistemas de observación existentes para incluir sismómetros, mareógrafos costeros y tsunámetros de aguas profundas a fin de suplir las carencias detectadas.
2. Implantar nuevas tecnologías para suplir las carencias en cuanto a las observaciones que no pueden ser cubiertas por las redes existentes. Esto incluiría la implantación generalizada de instrumentos científicos en los cables de telecomunicaciones de aguas profundas, como se ha hecho en el marco de la iniciativa sobre cables submarinos SMART del Grupo Especial Mixto UIT-OMM-COI/UNESCO, y que se ha presentado como programa para el Decenio de las Naciones Unidas de las Ciencias Oceánicas para el Desarrollo Sostenible.
3. Gran ampliación del acceso y la disponibilidad de los datos y desarrollo de la capacidad para obtener datos sobre el nivel del mar, sísmicos y de movimientos terrestres derivados del GNSS en tiempo real y casi real, con una tasa de muestreo adecuada, así como herramientas pertinentes de previsión sobre todas las fuentes de tsunamis.
4. Aumentar el acceso a la recopilación de datos batimétricos y topográficos costeros, y actualizarla periódicamente, en colaboración con el proyecto Seabed 2030 de la Nippon Foundation y el GEBCO, y disponer de capacidades computacionales de alto

rendimiento para posibilitar previsiones más oportunas, precisas y completas sobre tsunamis y otros peligros costeros que permitan orientar mejor las respuestas comunitarias.

5. Velar por que todos los centros nacionales de alerta contra los tsunamis tengan acceso a datos, herramientas y plataformas de comunicación, protocolos y formación para alertar oportuna y eficazmente a las comunidades costeras y marítimas amenazadas por los tsunamis y otros peligros costeros, y por que estén integrados en un marco de peligros múltiples.

**El Grupo recomendó** que el proyecto de plan decenal de investigación, desarrollo y ejecución del Programa del Decenio del Océano sobre los Tsunamis contribuyera a lograr el resultado social de “Un océano seguro”, con el objetivo de que el 100% de las comunidades con riesgo de tsunami estén preparadas y sean resilientes ante los tsunamis de aquí a 2030 mediante la ejecución del programa Tsunami Ready de la COI/UNESCO y otras iniciativas que incluyan, entre otras, las siguientes:

1. La adopción y aplicación continua de las directrices y los indicadores Tsunami Ready de la COI/UNESCO como norma de referencia internacional sobre la preparación comunitaria frente a los tsunamis basada en datos empíricos.
2. Mejora del acceso y desarrollo de capacidades en lo que respecta a los datos batimétricos y topográficos de alta resolución cerca de la costa y la identificación de posibles fuentes de tsunami para mejorar y hacer más precisos los modelos de inundación, los planos de evacuación y la planificación, a fin de lograr comunidades preparadas para casos de tsunami.
3. Mayor integración para minimizar el impacto de los desastres provocados por los tsunamis y facilitar el rápido restablecimiento de las actividades socioeconómicas y los servicios de las infraestructuras críticas tras el impacto de los tsunamis.

**El Grupo pidió** que la Asamblea de la COI, en su 31ª reunión, en 2021, considerara la posibilidad de aprobar la creación del Programa del Decenio del Océano sobre los Tsunamis y de un comité científico encargado de preparar el proyecto de plan decenal de investigación, desarrollo y ejecución de este Programa, con el mandato que figura en el apéndice 1 del anexo II del presente informe.

**El Grupo recomendó** a la Asamblea de la COI que, en su reunión de 2021, alentara a los Estados Miembros a conceder préstamos financieros voluntarios a las cuentas especiales de la COI y a aportar contribuciones en especie para apoyar el Programa del Decenio del Océano sobre los Tsunamis.

**El Grupo tomó nota con satisfacción** de los progresos realizados durante el periodo entre reuniones, a saber:

- Los ejercicios de preparación para los tsunamis Caribe Wave 20, PacWave20 y IOWave20, que tuvieron lugar en 2020 pese a la pandemia de COVID-19.
- La campaña UNDRR-COI de 2020, que incluyó eventos de alto nivel, seminarios web regionales, imágenes en los medios sociales, vídeos y relatos de testigos presenciales, así como la elaboración de 15 vídeos sobre los países que se unen a la comunidad mundial Tsunami Ready.
- El creciente interés y los excelentes progresos realizados por los Estados Miembros en todos los grupos intergubernamentales de coordinación de los sistemas regionales de

alerta contra los tsunamis en la aplicación experimental del programa Tsunami Ready de la COI/UNESCO.

- Los progresos notificados por Indonesia respecto a su solicitud de certificación ISO de un sistema comunitario de alerta temprana.
- La oportunidad de aprovechar las nuevas capacidades, como los sistemas de cables SMART (sistemas de cables para el seguimiento científico y la fiabilidad de las telecomunicaciones) y los datos de deformación terrestre basados en el GNSS, para mejorar la detección, la medición y la previsión en relación con los tsunamis, especialmente en las zonas poco observadas.
- La disponibilidad potencial de grandes volúmenes de datos topográficos y batimétricos a través de la iniciativa Seabed 2030 de la Nippon Foundation y el Mapa Batimétrico General de los Océanos (GEBCO), que es esencial para producir previsiones más precisas y oportunas sobre los tsunamis para todas las comunidades costeras.

**El Grupo recomendó** a la Asamblea de la COI que, en su 31ª reunión, en 2021, alentara a los Estados Miembros a:

- Utilizar las mejores prácticas en el diseño de ingeniería y la construcción de refugios de evacuación, especialmente cuando existen riesgos de tsunamis locales.
- Incluir como recurso la compilación del Centro de Información sobre los Tsunamis en el Océano Índico (IOTIC) de materiales escolares sobre reducción del riesgo de desastres y preparación, especialmente en el marco de las iniciativas piloto de Tsunami Ready que incluyen a las escuelas.

**El Grupo recomendó** a la Asamblea de la COI que, en su reunión de 2021, encargara a los grupos intergubernamentales de coordinación regionales lo siguiente:

- Continuar la estrecha colaboración entre la COI y la UNDRR para el Día Mundial de Concienciación sobre los Tsunamis de 2021, teniendo en cuenta que, el 5 de noviembre de este año, el Día Mundial pondrá de relieve la meta f) del Marco de Sendái, relativa a la cooperación internacional en favor de los países en desarrollo mediante el apoyo a la aplicación de sus estrategias nacionales y locales para la reducción del riesgo de desastres.
- Finalizar urgentemente las directrices de Tsunami Ready (Manuales y guías de la COI, 74) para su amplia distribución a los Estados Miembros.
- Incluir los procedimientos operativos estándar para tsunamis de origen local como un componente importante del programa Tsunami Ready de la COI/UNESCO.
- Elaborar módulos de formación estandarizados que puedan impartirse en línea o en persona, en particular a través de la Academia Mundial OceanTeacher.

**El Grupo pidió** a la Secretaría lo siguiente:

- Organizar una reunión virtual sobre los ejercicios WAVE de preparación para los tsunamis y coordinarla para minimizar los conflictos de fechas y compartir las mejores prácticas para la evaluación de los ejercicios y el uso de herramientas en línea.
- Organizar en fechas próximas una reunión virtual del Equipo de Trabajo del TOWS-WG sobre Gestión de Desastres y Preparación (TT DMP) sobre los indicadores clave del

desempeño, a fin de examinar un plan de trabajo para armonizar los marcos de supervisión del rendimiento en todos los grupos intergubernamentales de coordinación, que incluya la integración de la cooperación internacional en los indicadores clave del desempeño del CARIBE-EWS, el IOTWMS y el NEAMTWS.

**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 de trabajo 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 recomendó** que la Asamblea de la COI, en su 31ª reunión, en 2021, adoptara las siguientes medidas:

- Prolongar el mandato 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 y de sus equipos de trabajo sobre: i) gestión de desastres y preparación (TT DMP) y ii) operaciones de vigilancia de los tsunamis (TT TWO), con arreglo a los mandatos que figuran en la [resolución XXIV-14 de la COI](#) (para el TOWS-WG), el [anexo II del documento IOC/TOWS-WG-VI/3](#) (para el TT DMP) y el [apéndice 1 del anexo II del documento IOC/TOWS-WG-X/3](#) (para el TT TWO).



### *Резюме для руководящих органов*

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Четырнадцатое совещание рабочей группы по системам предупреждения и смягчения последствий цунами и других опасных явлений, связанных с изменением уровня моря (РГ-СПЦО-XIV), состоялось 25-26 февраля 2021 г. в онлайн-режиме под председательством г-на Александра Фролова (заместителя председателя МОК). В ходе совещания было проанализировано выполнение решения IOC-XXX/8.2, принятого Ассамблеей МОК на ее 30-й сессии (26 июня – 4 июля 2019 г., Париж).

**Группа вновь заявила** о том, что Десятилетие Организации Объединенных Наций, посвященное науке об океане в интересах устойчивого развития (именуемое далее «Десятилетие океана»), предоставляет уникальный шанс выявить и потенциально восполнить пробелы имеющихся функциональных возможностей путем использования новейших платформ, методов и/или инфраструктуры зондирования в целях более быстрого обнаружения, измерения и прогнозирования цунами, начиная с момента их формирования, а также для повышения готовности прибрежных общин к цунами в рамках программы МОК ЮНЕСКО по обеспечению готовности к цунами.

**Группа одобрила** документ «Защита общин от самых опасных волн в мире: рамочные принципы действий для Десятилетия Организации Объединенных Наций, посвященного науке об океане в интересах устойчивого развития» (приложение 1 к циркулярному письму 2825) в качестве рекомендательной основы для разработки проекта десятилетнего плана научных исследований, разработок и осуществления для программы по цунами в рамках Десятилетия океана, которая будет зарегистрирована в качестве мероприятия Десятилетия океана, и **рекомендовала** структуру управления этой программой.

**Группа также рекомендовала** ориентировать проект десятилетнего плана научных исследований, разработок и осуществления программы по цунами в рамках Десятилетия океана на достижение преобразующих результатов в области обнаружения, измерения и прогнозирования цунами, включая цунами несейсмического происхождения. **Группа рекомендовала** включить в эту программу следующие основные области, связанные с функциональными возможностями предупреждения о цунами:

1. Расширение существующих систем наблюдения, включая сейсмометры, прибрежные мареографы и глубоководные цунаметры, для заполнения выявленных пробелов в данных;
2. Внедрение новых технологий для устранения пробелов в наблюдениях, которые не могут быть охвачены существующими сетями. Эта работа будет включать повсеместное применение научных контрольно-измерительных приборов на глубоководных телекоммуникационных кабелях в соответствии с разработками совместной целевой группы МСЭ/ВМО/МОК ЮНЕСКО (СЦГ) по подводным кабелям SMART, что было представлено в качестве одной из программ Десятилетия ООН, посвященного науке об океане в интересах устойчивого развития;
3. Значительное расширение доступа к данным, наличие и развитие функциональных возможностей получения в режиме реального и близкого к реальному времени данных об уровне моря, сейсмических данных и данных о движении суши от ГНСС с надлежащей периодичностью выборки, а также соответствующих инструментов для прогнозирования цунами любого происхождения;

4. Расширение доступа к набору прибрежных топографических и батиметрических данных и его регулярное обновление в сотрудничестве с проектом «Морское дно-2030» Фонда «Ниппон» и ГЕБКО, а также использование высокоэффективных вычислительных средств, позволяющих более своевременно, точно и комплексно прогнозировать цунами и другие опасные явления в прибрежной зоне, с тем чтобы лучше консультировать население в отношении ответных мер;
5. Обеспечение доступа к данным, инструментам и коммуникационным платформам, протоколам работы и подготовке кадров для всех национальных центров предупреждения о цунами в целях своевременного и эффективного предупреждения прибрежных и морских общин, которым угрожают цунами и другие опасные явления в прибрежной зоне, а также их интеграция в систему предупреждения о множественных опасных явлениях.

**Группа рекомендовала далее** ориентировать проект десятилетнего плана научных исследований, разработок и осуществления программы по цунами Десятилетия океана на содействие достижению социального результата «Безопасный океан» (обеспечение к 2030 г. готовности и устойчивости к цунами 100% подвергающихся опасности цунами общин) посредством осуществления программы ЮНЕСКО/МОК по обеспечению готовности к цунами и других инициатив, включая, в частности, следующие:

1. Принятие и дальнейшее применение рекомендаций и показателей ЮНЕСКО/МОК по обеспечению готовности к цунами в качестве международного стандарта обеспечения основанной на фактических данных готовности общин к цунами;
2. Расширение доступа и укрепление потенциала в области сбора в прибрежной зоне высокоточных батиметрических и топографических данных и выявления потенциальных источников цунами в целях точного и усовершенствованного моделирования наводнений, а также составления карт и планирования эвакуации в поддержку общин, получивших сертификат готовности к цунами;
3. Усиление интеграции в целях сведения к минимуму последствий цунами и создания условий для быстрого восстановления социально-экономической деятельности и важнейших инфраструктурных служб после цунами.

**Группа просила** Ассамблею МОК рассмотреть на ее 31-й сессии в 2021 г. вопрос об учреждении программы по цунами в рамках Десятилетия океана—и образовании Научного комитета для подготовки проекта десятилетнего плана научных исследований, разработок и осуществления этой программы в соответствии с кругом ведения, включенным в добавление 1 к приложению II к настоящему докладу.

**Группа рекомендовала** Ассамблее МОК на ее сессии в 2021 г. призвать государства-члены к предоставлению добровольных финансовых займов на специальные счета МОК и взносов в натуральной форме в поддержку программы по цунами Десятилетия ООН.

**Группа приняла к сведению** с удовлетворением информацию о проведенной в межсессионный период работе, в частности о:

- проведении в 2020 г. учений «Волна-20» в Карибском, Тихом и Индийском океанах, несмотря на пандемию COVID-19;
- кампании УРСБ ООН-МОК-2020, включавшие мероприятия высокого уровня, региональные интернет-семинары, наглядные материалы для социальных сетей, видеоролики и рассказы очевидцев, а также создание 15 видеоматериалов о странах, присоединившихся к глобальному сообществу «Готовы к цунами»;

- растущем интересе государств-членов ко всем межправительственным координационным группам региональных систем предупреждения о цунами и выдающихся успехах, достигнутых ими в развертывании программы МОК ЮНЕСКО «Готовность к цунами»;
- ходе рассмотрения заявки Индонезии на сертификацию по ИСО системы раннего предупреждения на уровне общин;
- возможностях использования новых средств, таких как кабельные системы SMART (научный мониторинг и надежная связь) и данные о деформации суши, получаемые с помощью ГНСС, в целях повышения эффективности обнаружения, измерения и прогнозирования цунами, особенно в недостаточно охваченных наблюдениями районах;
- возможностях сбора в рамках инициативы «Морское дно-2030» Фонда «Ниппон»/Глобальной батиметрической карты океанов (ГЕБКО) больших объемов топографических и батиметрических данных, имеющих важное значение для подготовки более точных и своевременных прогнозов цунами для всех прибрежных общин.

**Группа рекомендовала** Ассамблее МОК на ее 31-й сессии в 2021 г. призвать государства-члены:

- использовать передовой опыт в области инженерного проектирования и строительства эвакуационных убежищ, особенно в районах, где существует местная опасность цунами;
- включить в список ресурсов подборку материалов по уменьшению опасности бедствий и обеспечению готовности к ним для школ, подготовленную Центром информации о цунами в Индийском океане (ЦИЦИО), особенно для экспериментальных проектов программы по обеспечению готовности к цунами, в которых участвуют школы.

**Группа рекомендовала** Ассамблее МОК на ее сессии в 2021 г. поручить региональным межправительственным координационным группам:

- продолжать тесное сотрудничество между МОК и УРСБ ООН в связи с проведением 5 ноября 2021 г. Всемирного дня распространения информации о проблеме цунами, который в этом году будет посвящен цели F Сендайской рамочной программы, касающейся международного сотрудничества с развивающимися странами путем оказания поддержки осуществлению их национальных и местных стратегий по уменьшению опасности бедствий;
- срочно завершить подготовку руководства по обеспечению готовности к цунами (Справочники и руководства МОК, серия 74) для его широкого распространения среди государств-членов;
- включить стандартные оперативные процедуры в отношении цунами местного происхождения в программу МОК ЮНЕСКО по обеспечению готовности к цунами в качестве одного из важных компонентов;
- разработать стандартные учебные курсы, которые могут проводиться в онлайн-режиме или в аудитории, в частности в рамках Глобальной академии Океан-инструктор (ГАОИ).

**Группа просила** Секретариат:

- организовать виртуальное совещание по учениям «Волна» и скоординировать их проведение таким образом, чтобы свести к минимуму совпадение дат, а также обменяться передовым опытом по оценке учений и использованию онлайн-инструментов;
- организовать в ближайшем будущем виртуальное совещание целевой группы РГ-СПЦО по ликвидации последствий бедствий и обеспечению готовности к ним (ЦГ-ЛПГ) по ключевым показателям эффективности (КПЭ) для обсуждения плана работы по согласованию рамок мониторинга эффективности между всеми межправительственными координационными группами (МКГ), в котором будет предусмотрено включение КПЭ по интеграции международного сотрудничества в КПЭ для КАРИБ-СРП, СПЦИО и СПЦСВАСМ.

**Группа утвердила** доклады целевых групп по предупреждению и ликвидации последствий бедствий и обеспечению готовности к ним, а также по наблюдению за цунами и поручила обеим группам продолжать работу по мониторингу цунами несейсмического происхождения и принятию ответных мер с возможным включением этого аспекта в деятельность по наблюдению за цунами.

**Группа рекомендовала** Ассамблее МОК утвердить в ходе ее 31-й сессии в 2021 г. следующие меры:

- продлить срок полномочий рабочей группы по системам предупреждения и смягчения последствий цунами и других опасных явлений, связанных с изменением уровня моря, и ее целевых групп (i) по ликвидации последствий бедствий и обеспечению готовности к ним (ЦГ-ЛПГ) и (ii) по наблюдению за цунами (ЦГ-НЦ) с сохранением за ними полномочий, предусмотренных в [резолюции МОК XXIV-14](#) (для РГ-СПЦО) и в [докладах IOС/TOWS-WG-VI/3](#), приложение II (для ЦГ-ЛПГ) и [IOС/TOWS-WG-X/3](#), приложение II (добавление I) (для ЦГ-НЦ).

## 1. OPENING AND WELCOME

### 1.1 OPENING

1. The Chair, Mr Alexander Frolov, opened the meeting and welcomed the participants. In his opening remarks, he drew attention to the achievements of the Intergovernmental Oceanographic Commission (IOC) over the last year, including the preparation of a draft Ocean Decade Implementation Plan by the IOC Secretariat with support from the Executive Planning Group (EPG), which was endorsed at the 75<sup>th</sup> session of the United Nations General Assembly ([A/RES/75/239](#)). He stressed that, of the seven outcomes described in this plan, outcome 5 ‘A safe ocean’ where life and livelihoods are protected from ocean-related hazards” is the most relevant to the work of Working Group on Tsunamis and Other Hazards related to Sea-Level Warning and Mitigation Systems (TOWS-WG). He highlighted the creation of a conceptual framework for an Ocean Decade tsunami programme, which was developed by a small TOWS-WG task force in cooperation with the IOC Tsunami Unit. He noted that this framework would be discussed under agenda [item 5](#) of this TOWS-WG session. Finally, he suggested that the Group consider the framework as a guiding document to aid the development of a ten-year research, development, and implementation plan for the UN Decade tsunami programme.
2. Mr Vladimir Ryabinin, Executive Secretary of IOC, provided welcoming remarks. He expressed his appreciation for the convening of the UNGA on the 31 December 2020, which allowed for the adoption of the ‘[Oceans and Law of the Sea’ resolution](#) which in paragraphs 303 to 307 recognised the IOC Implementation Plan for the United Nations Decade of Ocean Science for Sustainable Development (2021–2030). He highlighted that the implementation plan sets out seven outcomes and a structure in which they can be achieved; activities developed under this framework should therefore strive to develop ocean science in these areas. He mentioned that a call for actions for UN Ocean Decade programmes had been issued on 15 October 2020 with the deadline 15 January 2021. He also noted that on the 6 and 8 April 2021 a meeting of the Interim Decade Advisory Board is scheduled to discuss proposed programmes in response to that call.
3. He emphasised that the Decade provides an opportunity to revolutionise ocean science and that the TOWS-WG must be at the forefront of transforming and re-designing tsunami services, including by upgrading to a new generation of more holistic tsunami early warning systems. He stressed that the Decade not only provides the opportunity for innovation in ocean science and technology, but also to be heard and visible to governments. He also noted significant remaining challenges, drawing attention to the 2018 Indonesia tsunamis and the fast-paced changes occurring to an underwater volcano near Mayotte in the Indian Ocean which highlight the need to further understand and address non-seismic source tsunamis.
4. In closing, he reiterated that tsunami is an important element for the Decade, thanked participants for their commitment to further ocean science, and encouraged ambition in their proposals for the next decade.

### 1.2 ADOPTION OF AGENDA

5. The agenda was adopted as given in [Annex I](#).

### 1.3 WORKING ARRANGEMENTS

6. 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: <http://www.ioc-tsunami.org/tows-wg14>.

## **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)**

7. Ms Silvia Chacón Barrantes (Costa Rica), Chair of the Intergovernmental Coordination Group for the Tsunami and other Coastal Hazards Warning System for the Caribbean and Adjacent Regions (ICG/CARIBE-EWS), reported on ICG/CARIBE-EWS activities during 2020, highlighting significant impacts of the COVID-19 pandemics.
8. She noted that, despite worldwide travel restrictions which impeded ICG/CARIBE-EWS-XV convening in 2020, the ICG was able to perform two online officers' meetings and one webinar to report to Member States. In April 2021, they are also planning to have a session to discuss urgent matters.
9. She noted that CARIBE-EWS has continued to repair and extend its monitoring network after the 2017 and 2018 hurricane seasons. This process was affected by the pandemic due to travel restrictions. The Caribbean and Adjacent Regions Tsunami Sources and Models (CATSAM) continues to be updated regularly and will collaborate with the Caribbean Marine Atlas (CMA2). Also, minimum requirements for topographic and bathymetric data were finalized. She also noted a high dependence on the Internet for receiving tsunami warnings. Thus, CARIBE-EWS is exploring possible collaborations with Meteorological Offices to use alternative methods. A pilot project on issuing warning messages for tsunamis caused by volcanic sources has been proposed and is currently discussed by a dedicated Task Team.
10. She noted that CARIBE-EWS created a first version of a database of social scientists working on disaster risk reduction and related subjects. In addition, Tsunami Ready continues to spread in the region, with a growing number of communities granted recognition and many more working on their guidelines or seeking funding.
11. She noted that participation in Caribe Wave 2020 significantly decreased due to the pandemic, with most Member States performing communication tests. Caribe Wave 2021 will be held the 11 March 2021 with tabletop exercises encouraged because they are now better equipped to deal with pandemic conditions.
12. Finally, she noted that in addition to heavily impacting the Caribe Wave exercises and the intergovernmental coordination in 2020, COVID-19 also strongly impacted the Caribbean region on Tsunami Ready processes by delaying signal delivery and installation, definition of protocols, drills (that were downscaled to tabletops), verification visits, and recognition ceremonies.

#### **2.1.2 Indian Ocean Tsunami Warning and Mitigation System (IOTWMS)**

13. Prof. Dwikorita Karnawati (Indonesia), Chair of the Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System, reported on the activities of the Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWMS).
14. She reported that the ICG/IOTWMS has continued to maintain the operational readiness of the end-to-end tsunami warning system. The ICG/IOTWMS has adjusted well to the new online working environment, with Member State representatives and other stakeholders regularly engaged through online meetings, lecture series, and webinars, ensuring the progression of planned activities and furthering capacity development in the

region. To achieve this, the ICG has worked closely with the Indian Ocean Secretariat in Perth, Australia, and the Indian Ocean Tsunami Information Center (IOTIC) in Jakarta, Indonesia.

15. She reported on key activities implemented in 2020. On 7 August 2020, the IOC Tsunami Ready programme granted recognition to the first Indian Ocean communities, both of which are in India. A series of webinars were organised between the 4 and 9 September 2020 featuring expert sessions on piloting the Tsunami Ready programme in the Indian Ocean. This highlighted expanding regional interest in the Tsunami Ready programme in the region. In addition, a regional webinar on Tsunami Ready in Indian Ocean island States was conducted on 1 November 2020 in association with the World Tsunami Awareness Day (WTAD). A planned IOWave 2020 exercise was also conducted over a two-week period (6–20 October 2020) and, for the first time, involved three scenarios. However, due to COVID-19, the exercise was reduced to focus on national tsunami warning centres, with minimal downstream involvement. In preparation for the exercise, an IOWave 2020 webinar on SOPs for tsunami early warning and emergency responses was held by IOTIC and the Secretariat on 28–30 September 2020. Participants and preliminary analyses were reported on at the IOWave 20 webinar on lessons learned during the exercise of IOWave 2020.
16. As part of an extra-budgetary project funded by UNESCAP on strengthening tsunami early warning in the Northwest Indian Ocean through regional cooperation, the project team engaged with the participating Member States via online national consultations and regional workshops. A workshop on SOPs for tsunami early warning was held from 24 to 28 February 2020 and a workshop on harmonisation of national tsunami warning centre warnings was held online on 26 November 2020. The project also conducted a series of online national consultation meetings to discuss and monitor progress at the national level. A project update was reported at the 21<sup>st</sup> UNESCAP Advisory Council meeting on 5 November 2020.
17. She also reported that the intersessional meetings of ICG/IOTWMS were also held online in December 2020, including meeting of Working Group (WG) 1, the sub-regional WG for the Northwest Indian Ocean, WG 2, and the Steering Group. In total, 38 national representatives from 11 Member States, 5 invited experts, and 3 UN representatives attended these events. In addition, the Government of Indonesia has offered to host the 13<sup>th</sup> session of the ICG/IOTWMS. The session was originally planned for early 2021 but has been rescheduled to May 2022 (in Bali, Indonesia) due to the COVID-19 pandemic. The 13<sup>th</sup> session will be held back-to-back with the Global Platform for Disaster Risk Reduction (DRR), currently scheduled from 23 to 28 May 2022. In preparation for the 13<sup>th</sup> session, a pre-ICG intersessional meeting will be held online with tsunami national contacts during the second half of 2021 to maintain momentum and ensure effective planning. Decisions and elections will be excluded from the agenda of this meeting.
18. She expressed support for the UN Ocean Decade on behalf of the ICG/IOTWMS. She noted that national tsunami activities of Member States are currently being synthesised into regional programmes. She also noted that the ICG/IOTWMS urges the enhancement of tsunami early warning systems through understanding the risk, monitoring the threat, and disseminating warning, in particular of non-tectonic tsunami sources. In the spirit of the Ocean Decade, ICG/IOTWMS requests Indian Ocean Member States to support the sharing of seismic and other data to strengthen tsunami warning systems. They also encourage Member States to implement the IOC Tsunami Ready guidelines and indicators, as well as promote open access to high resolution near-shore bathymetry and topography data for accurate inundation and evacuation mapping in support of Tsunami Ready communities.
19. In closing, she emphasised that IOTWMS welcomes collaboration with regional and global stakeholders on initiatives for a predictable, safer, and accessible ocean for all.

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

20. Ms Maria Ana Baptista (Portugal), Chair of the Intergovernmental Coordination Group for Tsunami Early Warning and Mitigation System in the North-Eastern Atlantic, reported on ICG/NEAMTWS activities.
21. She reported on key activities which have taken place in the region over the last year. She reported that ICG/NEAMTWS participated in the TOWS-WG Inter-ICG TT DMP meeting the 18 and 19 February 2020, as well as the Twelfth session of TOWS-WG on 20–21 February 2020. The Steering Committee also convened on 21–22 April 2020 to discuss the NEAM Wave exercise. A special meeting of the Steering Committee was held on 15 June 2020 to decide on the NEAM Wave exercise (due to take place from 8 to 10 March 2021). They also had a meeting with the DG-ECHO on 9 July 2020 to discuss Phase 1 of the Tsunami Last Mile project.
22. She also reported that ICG/NEAMTWS started virtual webinar exercises, the first of which focused on the 2 May 2020 local tsunami in Crete, Greece, and reached many participants. For the World Tsunami Awareness Day, which took place from 3 to 10 November 2020, they proposed a regional webinar to highlight key advances in strategies to mitigate and prepare for tsunamis and improve preparedness to reduce tsunami risk. They emphasised achievement and challenges in the technical upstream of tsunami warning and mitigation systems and key pilot projects on tsunami risk reduction and discussed the implementation of local community recognition programmes such as Tsunami Ready. Although it was an overall success, the COVID-19 pandemic caused delays and connectivity issues, which impeded participation in the event. Key conclusions from this event included the acknowledgement of Tsunami Ready as an excellent model for mitigation, preparedness, and response to tsunami risk in the NEAM region. Two videos made by IOC-UNDRR, in collaboration with INGV (Istituto Nazionale di Geofisica e Vulcanologia, Italy), the Italian Civil Protection, NOA (National Observatory of Athens), KOERI (Kandilli Observatory and Earthquake Research Institute, Turkey), and Israel, were also presented at this event to commemorate WTAD. Finally, NEAMTWS supported a training in February 2021 for Emergency Response Coordination Centre (ERCC) duty officers to support the NEAM Wave exercise.
23. She reported on upcoming activities in the region, highlighting the following events:
- NEAM Wave exercise (8–10 March 2021);
  - International Tsunami Symposium in Sendai, Japan (if COVID-19 allows);
  - 17<sup>th</sup> session of the ICG/NEAMTWS: The date for this session has been pushed to 2022 due to the pandemic, with negotiations and drafting of a memorandum of understanding (MOU) under way.
24. She also reported that several documents had been created, highlighting the following:
- ICG/NEAMTWS Fact Sheet 2005–2020;
  - Consulting services, including DRR/EWS report in Maghreb and a draft report on the Status of Education, Awareness Raising and Tsunami Preparedness in the NEAM region;
  - Supporting documents and online tools for the NEAM Wave exercise.
25. In closing, she expressed her appreciation for the continued support of Mr Denis Chang Seng to the ICG/NEAMTWS.



#### 2.1.4 Pacific Tsunami Warning and Mitigation System (PTWS)

26. Dr Wilfried Strauch, Chair of ICG/PTWS, reported that the ICG/PTWS governance structure was maintained since the TOWS-WG 2020 meeting.
27. The Intergovernmental Coordination Group of PTWS is governed by a Steering Committee, and its work conducted through Technical and Regional Working Groups (WG) and Task Teams (TT), and supported by the PTWS Tsunami Service Providers (TSP), Pacific Tsunami Warning Center (PTWC), Northwest Pacific Tsunami Advisory Center (NWPTAC), South China Sea Tsunami Advisory Center (SCSTAC), developing Central America Tsunami Advisory Center (CATAC) and the International Tsunami Information Center (ITIC).
28. Since the ICG/PTWS-XXVIII (April 2019), all WGs and TTs have worked on their tasks and have carried out (mainly virtual) meetings and are reported to this TOWS-WG meeting. These are:
- WG 2 TT Draft Minimum Competency levels for National Tsunami Warning Centre (NTWC) Operations was piloted in October 2019 as training for Tonga and Solomon Islands staff with ITIC, PTWC, and IOC trainers; further development is being planned led by ITIC under the IOC Ocean Teacher Global Academy (OTGA);
  - WG 2 TT Integrated PTWS Sensor Networks for Tsunami Detection and Characterisation met in person at the 2019 Fall American Geophysical Union (AGU) session to discuss to optimal multi-instrument sensor network that integrates existing and emerging techniques and sensor technologies, for tsunami detection and characterisation;
  - PacWave 2020, due to COVID-19 restrictions, was reduced to a communications exercise from TSP to TWFP, with two regional exercises (South East Pacific, Central America) and some countries conducting further national exercises;
  - In coordination with UNAVCO, Member States worked to improve GNSS (Global Navigation Satellite System) data sharing in real time to improve tsunami impact forecasts for coastlines particularly for near-field events;
  - Cooperated in the Team on the preparation of a report on atypical tsunami sources for the TT TWO.
29. A virtual meeting of the ICG/PTWS Steering Committee was organized on 16–18 June 2020 to discuss the progress and problems in the work of the ICG. Main items discussed included the PacWave 2020 exercise, a draft PTWS Medium Term Strategy for 2022–2029, and the PTWS contribution to the UN Ocean Decade.
30. Most work conducted since March 2019 was through virtual meetings due to COVID-19. Although the ICG/PTWS-XXIX meeting was due to take place in March 2021 in Japan, it has been postponed to until November 2021 due to the COVID-19 restrictions, with a final decision for holding in November 2021, March 2022, or for cancelling, to be taken in May or June 2021. It was decided that a virtual meeting could not guarantee the efficient work needed and the proper election of new officers.
31. Despite the problems with COVID-19, Tsunami Service Providers (TSPs) continue to provide their services in a reliable and timely manner. The Pacific Tsunami Warning Center (PTWC) has maintained the high level of its products and the same holds true for the North West Pacific Tsunami Advisory Center (NWPTAC). The South China Sea Tsunami Advisory Center (SCSTAC) has worked in a routine manner since November 2019. Regular communications exercises continue. The Central American Tsunami Advisory Center (CATAC)

still performs in an experimental mode, continuing to capacitate personnel, finishing the elaboration of a tsunami database for fast tsunami products, and preparing and executing two tsunami exercises for Central America in August 2019 and on 11 November 2020. The latter were limited to tabletop exercises, and Honduras and Panama were unable to participate in November due to COVID-19. Within a Project on Earthquake Early Warning executed with the Swiss Technical cooperation, more than 70 accelerographic stations will be installed, in January–March 2021 along the Pacific Coast of Central America. These will improve the capacity for CATAAC and the NTWC's for the Tsunami Warning. A rapid process is ongoing in Central America for the real time exchange of high frequency GPS data that also will benefit the tsunami warning in the region. CATAAC continues to work to finalize the official recognition in the institutional scheme of the Nicaraguan Geosciences Institute, which is the host of CATAAC. Upon recognition, CATAAC will be recognized as a regional service within the Central America System of Integration (SICA) supported through the Coordination Centre for the Prevention of Natural Disasters in Central America (CEPREDENAC).

32. ICG/PTWS has observed that some national seismic services present certain problems in the maintenance of their monitoring networks due to COVID-19. In the Southwest Pacific, the ORSNET seismic network in particular has struggled to maintain a high-quality real time seismic monitoring system. Also, because the civil protection agencies have been focused on COVID-19, they have generally not been able to devote significant time to tsunami response, preparedness, and mitigation activities.
33. For South America, the Regional Working Group on Tsunami Warning and Mitigation in the South East Pacific Region continued to be active, holding regular regional tsunami warning center exercises to improve their coordination and data sharing during events. In the framework of the PacWave 21 in October, the WG conducted a regional exercise using the Tonga scenario and Peru played the role of the PTWC for issuing messages that were generated by the Tsunami Coastal Assessment Tool (TsuCAT).
34. Work continued in Chile, the United States of America, and New Zealand on the development of real-time operational algorithms for estimating surface deformation from GNSS data. This will provide more direct characterizations of the tsunami source, more accurate tsunami forecasts, and better more effective tsunami warnings. The faster forecasts will especially help against local tsunami threats.
35. New Zealand began deploying its planned 15 DART buoys to support tsunami detection and early warning for the Southwest Pacific region. Findings so far have led New Zealand to use DART data as an immediate source of information to adjust for the tsunami magnitude. These findings are important for other countries operating DART and New Zealand is developing a presentation to be shared with Member States soon.
36. The PTWS is beginning efforts to enhance ocean monitoring through submarine cable deployments, with French New Caledonia and Vanuatu pursuing tenders to deploy a SMART undersea cable. NOAA is seeking proposals for feasibility studies that support a Blue Economy. New Zealand's science and research and central government agencies are working to source funding for SMART cables in the Southwest Pacific.
37. Tsunami Ready activities were carried out successfully in Central America in March and April 2020. Activities have now been restricted to virtual meetings and tabletop work. Costa Rica has achieved six new Tsunami Ready communities in February 2021 (2 recognized and 4 provisionally recognized) and Ecuador is pursuing recognition for the Galapagos.
38. For WTAD 2020, short videos about countries joining Tsunami Ready were produced. For the Pacific, these included Costa Rica, New Zealand, Fiji, the Philippines, Samoa, Tonga,

USA Hawaii, and Vanuatu. Regional webinars were held, and the Pacific Tsunami Museum (Hawaii) and Indonesia (Banda Aceh) participated to the 3<sup>rd</sup> Tsunami Museum Conference.

39. On 23 April 2020, the ICG/PTWS released guidance on “[Tsunami Services and Evacuation/Sheltering Considering Physical Distancing Practices](#)” for Member States for tsunami warnings during the pandemic. These guidelines were also adopted by other ICGs.

40. The International Tsunami Information Center continued its support to the PTWS. It received designation as an OTGA Specialized Training centre, along with Indonesia BMKG. Together, they are planning to develop online and blended training, including on TWC SOPs, TEMPP, and Tsunami Ready. Outreach products, such as global and regional historical tsunami hazard posters, have been updated or newly created, and tsunami decision support tools maintained and updated. The TsuCAT, which includes pre-computed scenarios from the Pacific, Caribbean, and Indian Ocean, was upgraded to v4.2 to include generation of the PTWC enhanced products for Member State use in exercises.

## 2.2 REPORT OF NON-IOC BODIES

### 2.2.1 World Tsunami Awareness Day (UNDRR)

41. Denis McClean, Head of Communications at the United Nations Office for Disaster Risk Reduction (UNDRR), reported on this item.

42. He noted with appreciation the achievements of WTAD 2020, noting the collaborative effort of IOC, UNDRR, and other partners. He highlighted key WTAD 2020 events:

- Ready for the Next Wave!, a high-level event where IOC and UNDRR hosted their representatives from Japan, Indonesia, the Maldives, Jamaica, and Portugal.
- Third World Tsunami Museum Virtual Conference, which heard from museum representatives in Japan, Indonesia, Hawaii, Thailand, and Turkey. Some speakers were survivors, which had a strong impact on the online audience.
- A series of webinars were organized by IOC and UNDRR in several regions, including the Caribbean, Pacific Islands, Northeast Atlantic, and Southeast Pacific.
- A podcast (Chile). This format will likely be revisited for WTAD 2021.
- Regional offices hosted several events.
- Fifteen (15) short videos on Tsunami Ready communities were produced in collaboration with IOC. These are still being used and are useful at the expert level and for the general public. He expressed appreciation for the participation of the Secretary General in one video.

43. He recalled that the theme of WTAD 2020 was centered on Target E of the Sendai Framework for Disaster Risk Reduction 2015–2030 to “Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020”. So far, over 100 UN Member States have adopted these strategies.

44. He noted that WTAD 2021 will focus on Target F of the Sendai Framework to “Substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of this framework by 2030”. He recalled that the topic of international cooperation was discussed during the TT DMP meeting (22–23 February 2021). He noted that the Tsunami Ready programme is well suited for the theme of WTAD 2021, because many low- and middle-income countries rely on international cooperation and support to participate in this programme. Thus, Tsunami Ready will likely be heavily highlighted during WTAD 2021.

45. He noted that a challenge for WTAD 2021 is to find a newsworthy announcement to make on the day. A possible topic that has been mooted is to create a collaborative effort between IOC and other like-minded organizations such as UNDRR, WMO, and the Red Cross and Red Crescent Societies to support Tsunami Ready and help bring it to a global level.

### **2.2.2 World Meteorological Organization (WMO)**

46. Ms Sarah Grimes, Mr Timo Proescholdt, and Mr Cyrille Honoré reported on this item.
47. The presentation centered on the following topics: (i) Data delivery and information systems; (ii) WMO Reform and Technical Structures; (iii) Coastal Inundation Forecasting Initiative (CIFI) and Global Multi-hazard alert system (GMAS); (iv) WMO-UNDRR project on Multi-Hazard Early Warning Systems (MHEWS) indicators; (v) World Days; and (vi) WMO Ocean Side Events and Decade.
48. Mr Timo Proescholdt presented on WMO data delivery and information systems, and specifically the WMO Global Telecommunications System (GTS). He noted that COVID-19 pandemic had impacted tsunami warning and that this highlighted an issue of reliance on the Internet for disseminating warnings (he recalled Silvia Chacon's similar comment previously). An analysis of tsunami warning in the Caribbean shows that, of the 38 Member States, 20 focal points or tsunami warning centres use the GTS as an exchange mechanism. He presented statistics related to the timeliness of dissemination of the warnings in the Caribe Wave exercise. He noted that most messages arrived within a few minutes, with only a few outliers. Thus, the GTS could be further implemented to increase resilience and increase methods of dissemination.
49. He highlighted that the GTS is part of the larger WMO information system. Since it is used for alerting and sending critical messages, it aims to be reliable by providing dedicated links. To retrieve information from this network, connection with a GTS node is necessary. The WMO information system also provides additional services such as discovery of products.
50. He drew attention to the modernisation of the WMO GTS. With the implementation of WIS 2.0, GTS will be based on open standards and open message protocols and will enable real-time data-sharing. Access to this data and system is through a subscription and data is published via web services.
51. Ms Sarah Grimes presented an overview of the WMO reforms and technical structures, noting that the pandemic created delays. The most relevant new structure is the Services Commission. This includes several relevant sub-groups, such as the Standing Committee for Marine Meteorology and Oceanographic Services (SC-MMO), the Standing Committee for Disaster Risk Reduction (SC-DRR), the Infrastructure Commission (INFCOM), and the Research Board. IOC representatives are present in all groups except the SC-DRR. She also drew attention to the establishment of the WMO-IOC Joint Collaborative Board (JCB) which is the strategic advisory board made up of WMO and IOC advisors. The co-chairs are Louis Uccellini (WMO) and Monika Breuch-Moritz (IOC) and tsunami group representatives are Alexander Frolov (IOC) and Tom Cuff (WMO). She noted that several online meetings were held over the last year and JCB has developed a draft WMO-IOC Strategy to be submitted to WMO and IOC governing bodies for approval in June 2021. In terms of capacity development, a JCB member sits on the WMO Capacity Development Panel and the Chair of the WMO Capacity Development Panel is an observer to the IOC Capacity Development Group of Experts. She also noted that the tsunami and coastal inundation group can learn from this cooperation, in particular for early warning systems.
52. She also highlighted the Coastal Inundation Forecasting Initiative (CIFI), which was approved by Congress in 2019 ([Cg 18, Res. 15](#)). This initiative seeks to combine early warning

in coastal zones for all inundation sources. The CIFI ultimately aims to be incorporated into a multi-hazard early warning system. A guide has been drafted to explain how a coastal inundation early warning forecasting system should be implemented.

53. Mr Cyrille Honoré reported on progress related to the WMO Global Multi-hazard alert system (GMAS), a concept adopted at the 2019 WMO Congress. He highlighted that such an approach builds on and combines technological initiatives (such as CIFI) and components from other disciplines; the goal is to create an integrated framework. He noted that there is a need to both preserve countries' prerogatives and work within a spirit of integration.
54. He noted that, although the design of early warning systems is essential and has been at the forefront of literature and discussions, it is also important to consider monitoring and evaluation of the performance of multi-hazard early warning systems (MHEWS). WMO has collaborated with UNDRR for their project on developing warning systems custom indicators that could be included in the UNDRR Sendai Monitor. He expressed his appreciation for the lessons to be learned and contributions had from the evaluation practices of IOC.
55. Ms Sarah Grimes reported on World Days in which WMO was involved, including the following events:
- World Ocean Day 2020: For this event, a history of JCOMM (the Joint Technical Commission for Oceanography and Marine Meteorology), by Peter Dexter, was published. An ocean buoy awareness video was also created (available in English, French, Fijian, and Hindi) and provides a resource for interested groups.
  - World Meteorological Day (23 March 2021) has an ocean theme for the first time ("The Ocean: Our climate and weather") and provides an opportunity to showcase WMO's work on oceans as well as a platform for the ocean community.
  - WTAD 2021: WMO is interested in being included in the preparations for this event. She noted that it provides an opportunity to promote and acknowledge the role of meteorological agencies in tsunami warning.
56. She also highlighted that an ocean side event was held at the WMO regional association III (South America) and IV (North and Central America and the Caribbean). Requests in these regions centre around developing regional cooperation roadmaps for ocean agencies. In Central American and the Caribbean, there is an objective to strengthen coastal MHEWS, linking across to tsunamis.
57. In closing, she emphasised that WMO is interested in participating in the Ocean Decade, making reference to the the IOC Tsunami Unit's ambition to create an Ocean Decade programme proposal.
58. Following this intervention, the Chair opened the floor to comments and questions.
59. The Group enquired about categorisation (i.e. whether there will be a specific tsunami category) in the WMO Global Multi-hazard Alert System. In response, Mr Cyrille Honoré explained that the system is not currently user-friendly and that work on improving this is ongoing. Moreover, the categorisations were set up in collaboration with ITU and include specific arrangements; changing them is, therefore, time-consuming but is ongoing. He noted that they have a community platform exists for Member States and services to post and retrieve information, which they plan to revamp to render more user-friendly. He also noted that an information campaign was launched within WMO Member States to encourage registration of all national alerting agencies. An impediment to this is significant turnover within national centres which results in lost information.

60. The Group expressed appreciation for the support of WMO to the upcoming Caribe Wave exercise. It also highlighted the importance of including non-meteorological and hydrological agencies in warning systems, because these provide increasingly important data and communications. The need for acquiring different types of data was highlighted, and specifically the importance of near shore high resolution bathymetry. The Group noted the Seabed 2030 project under the Ocean Decade presents an opportunity for collecting extensive data, including in shallow areas.
61. The Group also enquired what integration of a tsunami early warning system would look like in day-to-day operations. Ms Sarah Grimes responded by noting that frustrations have been expressed at the national level due to lack of communication between sister national agencies (i.e. meteorological, hydrological, and oceanographic agencies). Integration for early warning needs to focus on bringing everyone to the table to encourage a better and more open exchange of data and information as part of a wider multi-hazard systems. Mr Cyrille Honoré added that the crux of the integration process is that information is convened and shared from various disciplines. He noted that the recent WMO Data Conference notably promoted wider and more open data exchange policies for its members. Alexander Frolov added that the JCB is also seeking more ambitious approaches for creating a global integrated warning system, but that the process is only beginning, with basic mechanisms being established for cooperation between UN organizations and different stakeholders.
62. The Group discussed the outliers for the Caribe Wave data previously presented by Mr Timo Proescholdt, noting that COVID-19 may have impacted the data or that it may be the result of a discrepancy between when data is received and when it is accessed.

### **2.2.3 International Federation of Digital Seismograph Networks (FDSN)**

63. Dr Sergio Barrientos, Chair of FDSN and Director of the National Seismological Center, Santiago, University of Chile, gave an overview of the FDSN and of advances on Global Navigation Satellite System (GNSS) activities for tsunami warning.
64. He reported the FDSN was established in 1986, in response to the realization that information exchange would be transformed with the advent of digital recording. The objective was to create standards for exchange of earthquake information and for a way to coordinate information. Key questions included how digital stations could be deployed more uniformly across the world and where new seismographic stations should be installed. The membership of FDSN is made up of groups responsible for the installation and maintenance of seismographs (these organizations need to operate more than one broadband station). Currently, membership includes 110 institutions in 78 countries. Within FDSN, member groups agree to coordinate station siting and to provide free and open access to their data.
65. He also reported on key achievements of FDSN, including the creation of the Standard for Exchange of Earthquake Data (SEED) format; the development of network codes assigned by the FDSN to provide uniqueness to seismological data streams; and real-time communications in rapid characterisation of earthquakes.
66. He reported on the organizational structure of FDSN, noting that it was comprised of five working groups in charge of different aspects of data exchange and provision. These working groups are: WG 1: Station siting and instrumentation; WG 2: Data exchange; WG 3: Coordination of products, tools, and services; WG 4: CTBT issues; and WG 5: Portable instrumentation.
67. He also reported that data is now being used to evaluate different characteristics of earthquakes which are useful to tsunami warning. GNSS can be applied to tsunami warning because it can provide information on the size of earthquakes, the geometry of the fault, and

the slip distribution of earthquakes. This provides useful information to estimate seafloor elevation changes. Current efforts are focused on moving into simultaneous, real-time provision of this information from the data. He notes that, although GNSS provides a useful tool for tsunami warning, it is less effective if the earthquake source is very far from the coast, as the only useful estimations are likely to be limited to earthquake magnitude.

68. Following this intervention, the Chair opened the floor to comments and questions.

69. The Group expressed interest in the potential that GNSS data provides for measuring tsunamigenic characteristics and enquired whether current operations are in real-time and include various data (beyond earthquake magnitude). Mr Segio Barrientes responded that, as of a month ago, they have included a module for estimation of fault slip based on GNSS data. He also noted that they are still considering how to integrate and evaluate all data together.

### 3. REVIEW OF PROGRESS

#### 3.1 STATUS OF IMPLEMENTATION OF [DECISION IOC-XXX/8.2](#)

70. Mr Bernardo Aliaga reported on Decisions adopted at the 30<sup>th</sup> session of the IOC Assembly (June 2019).

71. Mr Aliaga recalled the governance structure of IOC, noting that TOWS-WG is an advisory body which submits recommendations to the IOC Assembly. The latter chooses whether to approve these recommendations and instructs the ICGs and the Secretariat. The agenda items of the 53<sup>rd</sup> IOC Executive Council (held last month, online) only included urgent matters and thus excluded the TOWS-WG. The recommendations of the TOWS-WG 2020 session will therefore only be submitted to the IOC Assembly in June 2021.

72. With regards to ICG/CARIBE-EWS, he reported that the IOC Assembly had recommended the PTWC continue improving alerting systems and developing methods to alert staff of changes in sea level signals. He noted that this work is on-going. He also noted that no progress had been achieved with regards to the recommendation to share data and meta-data of Deep-ocean Assessment and Reporting of Tsunami (DART) buoy (or DART-like systems). He also highlighted that the Central America Tsunami Advisory Center (CATAC) started trial operations in August 2020 and a first regional tsunami exercise has occurred, involving Central American countries.

73. Mr Bernardo Aliaga noted that no specific recommendations exist for IOTWMS because they had not met before recommendations were sent to the IOC Assembly.

74. With regards to ICG/NEAMTWS, he reported that the IOC Assembly had suggested to follow up on the availability of sea level and seismic station networks. This will be discussed during the next Steering Committee of NEAMTWS. He noted that no new funding was available to NEAMTIC. Nevertheless, a European Union funded project (ECHO) of €1.2 million, which aims at supporting several countries in the region, is being developed.

75. With regards to the ICG/PTWS recommendation about developing methods to share real-time GNSS data for tsunami warning purposes, he reported that the Inter-ICG TT TWO has noted improvements on GNSS real-time data availability, but sharing is still in progress. He also noted that CATAC has started a trial for the Pacific coast of Central America in August 2019 and the SCSTAC began operations in November 2019.

76. With regards to TOWS-WG, an action had been established to facilitate support to countries and regions that have been impacted by a tsunami in order to have immediate surveys and collect event data in accordance with the Tsunami Survey TEAM (ITST) protocols.



He noted good progress on this recommendation, highlighting the International Symposium on the Lessons Learnt from the 2018 tsunamis in Palu and Sunda Strait (26–28 September 2019, Jakarta, Indonesia).

77. With regards to TOWS-WG recommendations addressed to ICGs, he briefly noted that the WTAD and IOC's partnership with UNDRR has been strongly advocated by ICGs. He also noted that work on the use of Performance Indicators (PI) by ICGs building on the PTWS Framework is ongoing. All ICGs were asked to continue piloting Tsunami Ready; this has been implemented and is on-going, with recognized Tsunami Ready communities in three ocean basins and on-going work in NEAM region.
78. In terms of progress on non seismic tsunamis, he noted that the work is reported by the Task Team on Tsunami Watch Operations in [Annex IV](#).
79. In terms of recommendations about the UN Ocean Decade, he noted that these will be discussed under [item 5](#) of this meeting.
80. In closing, Mr Bernardo Aliaga stressed that, although recommendations of TOWS-WG 2020 have not yet been endorsed by the IOC Assembly, they have begun to be implemented.

#### **4. REPORTS OF THE INTER-ICG TASK TEAMS**

##### **4.1 INTER-ICG TASK TEAM ON DISASTER MANAGEMENT AND PREPAREDNESS**

81. Mr David Coetzee reported on the outcome of the Inter-ICG Task Team on Disaster Management and Preparedness which met on 22–23 February 2021 on-line. The full summary of the Task Team meeting and its recommendations are provided in [Annex IV](#) of this report.

##### **4.2 INTER-ICG TASK TEAM ON TSUNAMI WATCH OPERATIONS**

82. Mr Charles McCreery reported on the outcome of the Inter-ICG Task Team on Tsunami Watch Operations which met on 22–23 February 2021 on-line. The full summary of the Task Team meeting and its recommendations are provided in [Annex III](#) of this report.

#### **5. UN DECADE OF OCEAN SCIENCE FOR SUSTAINABLE DEVELOPMENT**

83. Ms Alison Clausen, Programme Specialist of the IOC Marine Policy and Regional Coordination, presented an update of Ocean Decade and reported on this item.
84. She recalled that the vision of the UN Ocean Decade is “the science we need for the ocean we want”, noting that “ocean science” is intended as a broad and inclusive definition.
85. She also recalled the mission statement of the Decade, which is “transformative ocean science solutions for sustainable development, connecting people and our ocean”, meaning science that moves beyond a ‘business as usual’ approach.
86. She also recalled the Implementation Plan for the UN Ocean Decade and explained the structural framework of the UN Ocean Decade (bottom-up): Decade actions, Decade objectives, and Decade challenges (themes) together aim to achieve decade outcomes. She highlighted that the Implementation Plan was formally passed in a resolution by the UNGA on 31 December 2020 and the IOC's role as coordinator for the Plan confirmed.
87. She reported that Decade Actions will be identified through regular calls for actions, the first of which was opened in October 2020 and closed in January 2021. This has enabled



identification of foundational programmatic building blocs of the Decade as well as contributions that Member States or funding agencies could provide. The first call for Actions yielded about 220 programme submissions and 30 contribution submissions. She expressed appreciation for the amount and quality of submissions as well as high diversity in proponents.

88. She reported on key themes and regions denoted by submissions, noting the fewest number of submissions related to Challenge 6 on enhanced multi-hazard early warning services and community resilience. This highlights significant opportunity to establish more programmes related to this challenge.
89. She provided a timeline for next steps. Analysis of submissions is currently underway, with submissions being sorted into those which are already at the programme level, those which have the potential to be, and those which are at the project or activity level. Clusters, synergies, and linkages are being identified and developed between related submissions. The first group of Decade Actions will be presented to the Interim Decade Advisory Board in April 2021 to begin the endorsement process. IOC governing bodies will grant the final decision on endorsement. Thematic and geographical gaps in submissions will also be identified and preparations will be made to address them. In the next months, dialogue with proponents will be on-going, and a dialogue process linking resources providers and funders will also be developed.
90. She reported that from March through to the end of the year, the Global Stakeholder Forum—a new online engagement platform for different communities of practice—will be established, which will hopefully provide a significant role as a lead convener of the tsunami community of practice. In May and June, the formal kick-off of the Decade will take place. The previously planned Berlin kick-off conference has been replaced with an online process, key events of which include: the high-level virtual segment of the First International Ocean Decade Conference (1 June 2021), the Ocean Laboratories (June–July 2021), regional kick-off events (3<sup>rd</sup> and 4<sup>th</sup> quarter of 2021). The UN Ocean Conference is due to take place in Lisbon in 2022.
91. She highlighted different methods to engage in the UN Ocean Decade, including the submission of Decade activities and Decade actions, registration in the Global Stakeholder Forum, participate in National Decade Committees or regional initiatives, support Decade coordination support structures, join thematic working groups, and participate in events (Ocean Decade Laboratories and Ocean Decade Virtual Series).
92. Mr Mike Angove (USA), as lead for the small Task Force established by the Chair of TOWS-WG, introduced the main elements of the proposed Framework for the Tsunami Programme participation in the UN Ocean Decade.
93. He noted that contributions to the UN Ocean Decade are Member State driven initiatives. He recalled that there is an existing framework for people-centered early-warning systems which includes risk knowledge, monitoring and warning, warning dissemination and communication, and response capability. The TT also considered that capacity development (specifically for SIDS and LDCs) is essential to the framework to ensure that everyone has access to the same capabilities for tsunami warning and resilience.
94. He reviewed the timeline for the Decade tsunami programme proposal. From February 2018 to September 2020, preparations were underway including publishing the OO19 paper and the framework document and conducting regional consultations. The 15 October 2020 call for actions was followed by a review and update of the Tsunami Framework document in November and December. Through an email on 21 December 2020, Alexander Frolov requested the endorsement of this framework by ICGs. On the 4 January 2021, Member States received [Circular Letter 2825](#) requesting information on their planned contributions to the UN Ocean Decade. He noted that responses had been good, highlighting relevant

recommendations from TT TWO and TT DMP. This meeting provides the opportunity for the TOWS-WG to consider recommending this framework as a Decade programme.

95. Mr Bernardo Aliaga presented the Member States' responses to CL-2825, noting that a document entitled *Analysis and Consolidated Inputs to the Ocean Decade Questionnaire – Inventory of actions being considered under the United Nations Decade of Ocean Science for Sustainable Development (2021–2030) – Tsunamis and Other Sea-Level Related Hazards* is available with detailed responses. He also noted that the Chairs of each region were tasked with consolidating Member States' responses.

96. The Secretariat recommended that this initial input is supplemented by focused requests to ensure more countries contribute to this effort.

97. Mr Bernardo Aliaga presented a summary of the inputs by themes:

- Risk knowledge: He highlighted the Probabilistic Tsunami Hazard Assessment (PTHA) initiative in Indian Ocean – Makran (led by Geoscience Australia in cooperation with ICG/IOTWMS) and an initiative in the South West Pacific.
- Monitoring and warning: He highlighted a process for the deployment of 12 DART buoys in the Tonga Trench, the smart cable initiative, and GNSS related initiatives.
- Warning dissemination and communication: He highlighted the aim to broadcast warnings under a multi-hazard system and strengthen end-to-end warning chains.
- Response capability: He highlighted Tsunami Ready, the New Zealand Blue-Line project, which is being considered by several other countries, and WTAD which builds preparedness.
- Capacity development and attention to small island developing States (SIDS) and least developed countries (LDCs): He highlighted key initiatives related to remote training such as the OTGA, regular technical training, Wave exercises, national drills, and WTAD.

98. The Chair of the TT DMP recalled recommendations of TT DMP on the UN Decade and the Chair of the TT TWO recalled recommendations of TT TWO on the UN Decade.

## **6. OTHER ISSUES**

99. No other issues were reported.

## **7. DATE AND PLACE OF THE NEXT MEETING**

100. The Chair and Technical Secretary will establish the date and place of the 15<sup>th</sup> meeting of TOWS-WG.

## **8. CLOSURE OF MEETING**

101. Mr Alexander Frolov expressed his sincere thanks for the ambition of recommendations during this meeting, highlighting developments of tsunami early warning systems based on new technology and scientific advances as well as increased broad cooperation between key stakeholders during the implementation of Tsunami Ready. In closing, he also expressed thanks to the Secretariat and the Group for a fruitful and successful meeting.

102. The Fourteenth meeting of TOWS-WG was closed at 19:20 (UTC) on 26 February 2021.

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)**
- 2.2 REPORT OF NON-IOC BODIES
  - 2.2.1 World Tsunami Awareness Day (UNDRR)**
  - 2.2.2 Report from World Meteorological Organization (WMO)**
  - 2.2.3 International Federation of Digital Seismograph Networks (FDSN)**

**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 Fourteenth Meeting of the Working Group on Tsunamis and Other Hazards related to Sea-Level Warning and Mitigation Systems (TOWS-WG-XIV) was held online, on 25–26 February 2021 under the Chairship of Mr Alexander Frolov (IOC Vice-Chair). The meeting evaluated the progress made in respect to the decisions [IOC-XXX/8.2](#) of the IOC Assembly at its 30th session (26 June–4 July 2019, Paris).

The Group confirmed that the UN Decade of Ocean Science for Sustainable Development provides a once-in-a-generation opportunity to address and potentially fill capability gaps by leveraging novel sensing platforms, techniques and/or infrastructures in order to more quickly detect, measure, forecast and warn for tsunamis, even from the near-instant they form, and to enhance the preparedness of coastal communities for tsunamis through the UNESCO/IOC Tsunami Ready Programme;

The Group endorsed the document “*Protecting Communities from the World’s Most Dangerous Waves: A Framework for Action under the UN Decade of Ocean Science for Sustainable Development*” (annex 1 to [Circular Letter 2825](#)) as a guiding document to develop a Draft 10-Year Research and Development and Implementation Plan for the *Ocean Decade Tsunami Programme (the programme)* and recommended the following governance structure for *the programme*:

1. The TOWS-WG will perform Global Steering Committee functions for *the programme*;
2. A Scientific Committee with Terms of Reference included in [Appendix 1](#) of Annex II to this report, with an advisory role for the duration of *the programme* will be established with 4 members nominated by each of the TOWS-WG Task Teams and 3 members nominated by the TOWS-WG on the basis of their scientific expertise. All members will serve for a period of two years and would be eligible for renewal once;
3. The Scientific Committee will be tasked to develop a Draft 10-Year Research, Development and Implementation Plan for *the programme* for endorsement by the TOWS-WG at its next meeting;
4. The four Intergovernmental Coordination Groups (ICGs) will perform regional Steering Committee functions, including implementing coordinating roles for the regional aspects of *the programme*;
5. A special Coalition for Tsunami Ready will be established in collaboration with other critical stakeholders across the UN structure as well as national civil protection agencies and will report to the TOWS-WG on Tsunami Ready aspects of *the programme*.

The Group also recommended that the Draft 10-Year Research, Development and Implementation Plan for the *Ocean Decade Tsunami Programme (the programme)* is dedicated to achieving transformational advances in tsunami detection, measurement and forecasting, including tsunamis generated by non-seismic sources. The Group further recommended that *the programme* include the following focus areas related to tsunami warning capabilities:

1. Expansion of existing observational systems including seismometers, coastal tide gauges, and deep ocean tsunameters to fill identified gaps;

2. Deploy new technologies to address observational gaps that cannot be covered by existing networks. This would include the widespread implementation of scientific instrumentation on deep-ocean telecommunications cables as developed by the ITU/WMO/UNESCO-IOC Joint Task Force (JTF) SMART Subsea Cables effort and submitted as a Programme to the UN Decade of Ocean Science for Sustainable Development;
3. Wide expansion of data access and availability and development of capability for real-time and near-real time sea level, seismic and GNSS-derived land motion data at an appropriate sampling rate and relevant tools to forecast tsunamis from all sources;
4. Increase access and regularly update the collection of coastal topographic and bathymetric data, in collaboration with Seabed 2030, as well as high performance computational capabilities to enable more timely, accurate and comprehensive tsunami and other coastal hazard forecasts to better advise community response;
5. Ensure all National Tsunami Warning Centres have access to data, tools and communication platforms, protocols and training to timely and effectively warn coastal and maritime communities threatened by tsunamis and other coastal hazards and are integrated into a multi hazard framework.

The Group further recommended that the Draft 10-Year Research, Development and Implementation Plan for the *Ocean Decade Tsunami Programme (the programme)* contribute to achieving the societal outcome of “A Safe Ocean” 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 Programme and other initiatives to include, but not limited to:

1. The adoption and continued implementation of the UNESCO/IOC Tsunami Ready Guidelines and Indicators as the international standard for evidence-based community preparedness for tsunamis;
2. Enhanced access and capacity development for high-resolution near shore bathymetric and topographic data and identification of potential tsunami sources for accurate and improved inundation modelling and evacuation mapping and planning in support of Tsunami Ready communities;
3. Enhanced integration to minimize tsunami disaster impacts and to enable rapid restoration of socio-economic activities and critical infrastructure services post tsunami impacts.

The Group requested that the IOC Assembly at its 31<sup>st</sup> session in 2021 consider approving the establishment of the Ocean Decade Tsunami Programme and the Scientific Committee to prepare the Draft 10-Year Research, Development and Implementation Plan for this programme with Terms of Reference included in [Appendix 1](#) of Annex II to this report;

The Group recommended to the IOC Assembly at its 31<sup>st</sup> session in 2021 to encourage Member States to provide voluntary financial contributions to the IOC special account and in-kind contributions to support the Ocean Decade Tsunami Programme;

The Group noted that ITIC and the Indonesia BMKG have been designated as Ocean Teacher Global Academy Specialized Training Centres (OTGA STC) in 2020. It further noted the confirmation by ITIC that it will take the lead to develop such training under the OTGA, in collaboration with the IOC, TICs, practitioner experts, and Indonesia BMKG;

The Group recommended that ITIC report to the TT DMP on the progress of the OTGA trainings at the next meeting of the TOWS-WG;

The Group reviewed reports by the IOC Intergovernmental Coordination Groups as well as its own Task Teams on Disaster Management and Preparedness and Tsunami Watch Operations;

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

- The Caribe Wave 20, PacWave20, and IOWave20, exercises which took place in 2020 despite the COVID-19 pandemic;
- The UNDRR IOC 2020 campaign consisting of high-level events, regional webinars, social media visuals, videos, and eyewitness accounts, as well as the creation of 15 videos highlighting countries joining the global Tsunami Ready community;
- Growing interest and excellent progress by Member States in all ICGs in piloting UNESCO/IOC Tsunami Ready;
- The progress by Indonesia in their application for ISO certification of a Community Based Early Warning System;
- That the opportunity now exists to leverage new capabilities such as SMART (Scientific Monitoring and Reliable Telecommunications) cable systems, and GNSS-based land deformation data in order to improve tsunami detection, measurement and forecasts particularly in under-observed areas;
- That large volumes of topographic and bathymetric data will likely be made available through the Nippon Foundation/General Bathymetric Chart of the Oceans (GEBCO) Seabed 2030 initiative, and that these data are essential for producing more accurate and timely tsunami forecasts to all coastal communities.

The Group recommended to the IOC Assembly at its 31<sup>st</sup> session in 2021 to encourage Member States to:

- Use best practices in engineering design and construction of evacuation shelters, especially where local tsunami hazards exist;
- Include the IOTIC compilation of school DRR and preparedness materials as a resource, and especially as part of Tsunami Ready pilots that include schools.

The Group recommended the IOC Assembly at its 31<sup>st</sup> session in 2021 to instruct the regional Intergovernmental Coordination Groups to:

- Continue the strong collaboration between the IOC and UNDRR for the 2021 WTAD, noting that the 2021 WTAD, November 5, will highlight Target F of the Sendai Framework on international cooperation to developing countries through support to the implementation of their national and local strategies for disaster risk reduction;
- Urgently complete Tsunami Ready Guidelines (IOC Manuals and Guides, 74) for widespread distribution to Member States;
- Include local source tsunami Standard Operating Procedures as an important component of the UNESCO/IOC Tsunami Ready programme;

- Develop standardized trainings that can be delivered online or in person, in particular through the Ocean Teacher Global Academy (OTGA);
- With regard to the next Tsunami Symposium, incorporate more diversity in the organizing 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.

The Group requested the Secretariat to:

- Organize a virtual meeting on WAVE exercises to coordinate so as to minimize date conflicts and share best practices for exercise evaluation and the use of online tools;
- Arrange a virtual meeting of the TT DMP on key performance indicators (KPIs) in the near future to discuss a work plan for harmonizing performance monitoring frameworks across all the ICGs, that include KPIs for integrating international cooperation into the KPIs of CARIBE-EWS, IOTWMS, and NEAMTWS;
- Identify possible funding sources to translate the Japan best practice document to English and other languages.

The Group accepted the reports from the Inter-ICG Task Teams on Disaster Management & Preparedness, and 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 recommended that the IOC Assembly at its 31<sup>st</sup> session in 2021 take the following action:

- To extend the tenure of the Working Group on Tsunamis and Other Hazards related to Sea-Level Warning and Mitigation Systems and its Task Teams on: (i) Disaster Management & Preparedness (TTDMP), and (ii) Tsunami Watch Operations (TTTWO), with terms of reference as given in [IOC Resolution XXIV-14](#) [for TOWS-WG], report [IOC/TOWS-WG-VI/3, Annex II](#) [for TTDMP] and report [IOC/TOWS-WG-X/3, Annex II \(Appendix 1\)](#) [for TTTWO].

#### Appendix 1

#### **Terms of reference: Ocean Decade Tsunami Programme Scientific Committee**

The Scientific Committee has an advisory role for the duration of *the programme*.

#### Membership:

- Four (4) members nominated by the each of the TOWS-WG Task Teams
- Three (3) members nominated by the TOWS-WG on the basis of their scientific expertise
- All members will serve for a period of two years and would be eligible for renewal once

The Scientific Committee will:

1. 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*”;
2. Identify gaps in a comprehensive global tsunami hazard assessment including all potential tsunamis, anywhere in the world, regardless of their source;
3. Identify gaps in tsunami detection, measurement, forecasting, with a special emphasis on tsunamis generated close to populated coastlines;
4. 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;
5. Propose a roadmap for collaboration with the JTF ITU/WMO/IOC SMART cable initiative to fully explore the feasibility of widespread deployment of scientific instrumentation on deep-ocean fiber-optic cables to improvement of the capability to rapidly detect and characterize tsunami sources as well as propagating tsunami wave fields;
6. Consider and propose strategies, programmes, and content to enhance societal resilience for tsunami and other ocean hazards;
7. Overview the consolidation of inputs to IOC Circular Letter 2825 *Inventory of actions being considered under the United Nations Decade of Ocean Science for Sustainable Development (2021–2030) - Tsunamis and Other Sea-Level Related Hazards*;
8. Submit a Draft 10-Year Research, Development and Implementation Plan for endorsement by the TOWS-WG at its next session.



ANNEX III

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

22–23 February 2021  
Online

**1. OPENING AND MEETING ORGANIZATION**

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 introduced the provisional meeting agenda, which was adopted with one addition: a new agenda item on IUGG Tsunami Commission recent activities was added as agenda item 7 (refer to [Appendix 1](#)). He noted that due to this being a much shorter virtual meeting due to the COVID-19 pandemic that presentations and discussions would need to be abbreviated and he thanked the participants for their cooperation.

**2. REVIEW OF ACTION ITEMS FROM THE PREVIOUS TT TWO MEETING**

Dr McCreery reviewed actions from the TT TWO meeting held in Paris, France (18-19 February 2020), that are not covered under other agenda items of this meeting (ref: [Summary Report, TOWS-WG, Thirteenth Meeting, Annex IV, Section 17.1, page 15](#)). The status of those actions is listed below:

Action Item	Status
<p><b><u>2020 Action 2:</u></b> 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).</p>	<p>Discussions ongoing.</p> <p>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.</p> <p>Mr Pattabhi Rama Rao Eluri briefed that CAP implementation for Indian Ocean was discussed extensively in the IOTWMS. As per the current arrangements, the 3 IOTWMS TSPs (Australia, India and Indonesia) are sending the notifications to Indian Ocean Member States that contain a link to their password protected TSP websites. IOTWMS felt that CAP is more appropriate at the national level rather than at the regional TSP level and that adding a link to CAP in the TSP websites would not serve the intended purpose. Hence, it was recommended by the IOTWMS to encourage and assist the NTWC Member States to implement CAP in their national service,</p>

Action Item	Status
	including developing CAP guidance for NTWCs.
<b>2020 Action 3:</b> IOC Secretariat to explore the possibility of providing links to TSP websites on the IOC TSU Webpage.	Ongoing. Will be shortly available.
<b>2020 Action 4:</b> IOC Secretariat to provide links to important tsunami related documents and technical manuals in a readily accessible web page on the IOC TSU programme.	Done.

### 3. STATUS OF IMPLEMENTATION OF THE TOWS-WG REQUESTS TO THE TT TWO

Dr McCreery reviewed the recommendations made by TOWS-WG relevant to TT TWO during the last meeting held in Paris, France, 18-19 February 2020 that are not covered under other agenda items of this meeting (ref: [Summary Report, TOWS-WG, Thirteenth Meeting, Annex II, page 2](#)). The status of recommendations is listed below:

Recommendation	Status
<b>2020:</b> to 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.	Ongoing.  Mr Yuji Nishimae shared news on the Nippon Foundation – GEBCO Seabed 2030 Project, a 10-year project with goal of having 100% of the ocean floor mapped by 2030. This effort can feed into this particular recommendation of the TOWS-WG.
<b>2020:</b> to 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.	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.
<b>2020:</b> to 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	Ongoing / on hold.  PTWS: this item was not discussed yet as their ICG meetings are biennial.

Recommendation	Status
<p>multiple platforms such as the Global Meteo Alert System (GMAS) under development by World Meteorological Organization.</p>	<p>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.</p> <p>As noted in Section 3, Action 2 above, the IOTWMS is encouraging and assisting their Member States to implement CAP in their national service messages.</p> <p>Updates were not available on this issue from the CARIBE-EWS.</p>

#### 4. TSUNAMI WATCH OPERATIONS - CURRENT STATUS AND PLANS

Dr McCreery noted the challenges faced by TSPs and NTWCs during the pandemic to ensure their continuity of operations and invited the ICG representatives to report on current watch operations status and plans within their ICGs.

##### 4.1 PACIFIC TSUNAMI WARNING AND MITIGATION SYSTEM (PTWS)

###### 4.1.1 South China Sea Tsunami Advisory Center (SCSTAC)

Dr McCreery briefed on the South China Sea Tsunami Advisory Center (SCSTAC) that started operating a few months before the last TT TWO meeting. There were a few events during the past year meeting criteria for an SCSTAC tsunami product. All were informational as events were below the threat threshold. The SCSTAC will report on its operations at the next ICG/PTWS Meeting.

###### 4.1.2 Central American Tsunami Advisory Centre (CATAC)

Dr Wilfried Strauch gave an update on the Central American Tsunami Advisory Centre (CATAC). He said that CATAC has progressed in the last year and finished development of a tsunami database for the fast lookup of tsunami simulations, as well as the capability for real time numerical simulation. CATAC is making use of another project on earthquake early warning: the installation of seismometer stations along the Pacific coast from Guatemala to Costa Rica (more than 70 stations) is ongoing and it will permit very fast locations and preliminary magnitudes of significant earthquakes. Moreover, he highlighted the execution of successful trainings. CATAC has established a simulation of the worst-case possible earthquake and provided in collaboration with the TWCs documents for the trainings. An effort has yet to be done to reach institutional level in order to get additional funding for CATAC operations.

###### 4.1.3 Northwest Pacific Tsunami Advisory Center (NWPTAC)

Mr Yuji Nishimae briefed that the Northwest Pacific Tsunami Advisory Center (NWPTAC) of the Japan Meteorological Agency (JMA) did not register any significant tsunamigenic earthquake events during the past year. He also reported that the COVID-19 crisis has postponed a session of ICG that was planned for March 2021 and it will be hosted by Japan and held either in November 2021 or March 2022. The PacWave20 exercise was conducted on 5 November 2020 and was also been reduced in scope.

#### 4.2 NORTH-EASTERN ATLANTIC AND MEDITERRANEAN TSUNAMI EARLY WARNING AND MITIGATION SYSTEM (NEAMTWS)

Dr Francois Schindel  and Mr Fernando Carrilho reported on recent developments in the North-Eastern Atlantic and Mediterranean Tsunami Early Warning and Mitigation System (NEAMTWS). There are five TSPs in the NEAMTWS with at least two TSPs monitoring each sub-basin. In the NEAMTWS region, authoritative alert levels are contained within the TSP messages (information, advisory and watch). He also reported that the NEAMWave exercise that was scheduled for 2020 has been postponed to 8–10 March 2021, due to COVID-19 pandemic. Three different scenarios will be organized: North-Eastern Atlantic (IPMA and CENALT), Central Mediterranean (INGV) and Eastern Mediterranean (NOA and KOERI). Three phases are part of NEAMWave21 exercise including Phase A: From TSP to NTWC and TWFP; Phase B: NTWC and TWFP to CPA and DMO; and Phase C: Member States could request support from European Union (DG-ECHO).

#### 4.3 TSUNAMI AND OTHER COASTAL HAZARDS WARNING SYSTEM FOR THE CARIBBEAN AND ADJACENT REGIONS (CARIBE-EWS)

Dr Elizabeth Vanacore confirmed that the CaribeWave21 exercise will take place on 11 March 2021 with two scenarios. A second webinar on communication and running such exercises in the light of COVID-19 will be undertaken this week. There is an ongoing volcanic crisis in Soufriere Volcano, Saint Vincent and the Grenadines (SVG). The Seismic Research Centre is supporting the National Emergency Management Agency of SVG in response to this crisis. Nevertheless and despite the pandemic and other disaster risk reduction challenges, the CARIBE-EWS is proceeding with its Tsunami Ready programme implementation

#### 4.4 INDIAN OCEAN TSUNAMI WARNING AND MITIGATION SYSTEM (IOTWMS)

Mr Pattabhi Rama Rao Eluri made a presentation on the status of the IOTWMS. The three operational TSPs of IOTWMS (Australia, India, Indonesia) have been providing interoperable tsunami threat information to the National Tsunami Warning Centres (NTWCs), which are responsible for the provision of detailed tsunami threat information for coastal regions. The seismic and sea level networks were sustained, and tsunami detection, warning and dissemination services have been strengthened with the Tsunami Service Providers (TSPs). Significant achievements include: 1) TSP Australia's tsunami warning service branch at the Bureau of Meteorology achieved ISO 9001 certification as a quality managed system; 2) TSP India's dedicated website (<https://tsunami.incois.gov.in>) was launched for both National & Regional operations; and 3) TSP India's launch and proposal of a new dissemination tool (WRS) to NTWCs. The IOTWMS also prepared a report on 'Impacts of COVID-19 Pandemic on IOTWMS Monitoring Networks and Tsunami Service Providers'.

Mr Eluri reported that the IOTWMS conducted the IOWAVE20 Exercise for three scenarios (Java Trench, Andaman Trench and Makran Trench) on 6, 13, and 20 October 2020 respectively. IOTWMS also organized Pre- and Post- IOWAVE20 Exercise Workshops online. A communications test was conducted in June 2020 with email emerging as the most successful means of communication followed by the Global Telecommunication System (GTS). A communication test could not be conducted in December 2020 due to the IOWAVE20 exercise that was conducted in October 2020. He reported on the performance of the TSPs against the Key Performance Indicators (KPIs) and TSP future plans.

### 5. SIGNIFICANT OPERATIONAL EVENTS IN THE INTER-SESSIONAL PERIOD

The list of significant operational events with USGS  $M_w \geq 6.5$  and/or events that caused significant tsunamis in the inter-sessional period are listed in [Appendix 3](#).

## 5.1 PTWS

Dr McCreery reported that 23 Tsunami Information Statements were issued by PTWC for the PTWS during the past year. The magnitudes of these events ranged from 6.5 to 7.1 and a few generated small tsunami waves. Seven events prompting Threat Messages ( $M_w$  7.1 to 7.7) occurred. The Loyalty Islands earthquake and tsunami of 10 February 2021 was the most significant of these events. It produced a tsunami that did not exceed 1 m but it propagated as far away as the coasts of New Zealand and Australia with amplitudes above 0.3 m. Dr McCreery stated that PTWC forecasting for these events based on the WCMT earthquake mechanism and RIFT forecast model was satisfactory. He noted that this was a good test for the new DART buoys recently been deployed in the southwest Pacific by New Zealand, and that the tsunami was observed on two or three of those deep-ocean gauges. Nevertheless, he explained that some coastal gauges nearer the earthquake recorded erratic signals and he emphasized the importance of sea level data quality control.

Mr Yuji Nishimae reported that the North-West Pacific region covered by NWPTAC did not have any significant earthquakes in the past year. The most significant earthquake occurred off Honshu, Japan (in an area similar to the 2011 Tohoku earthquake and tsunami) on 13 February 2021 with  $M$  7.1 with several smaller aftershocks and some small tsunami waves observed along Japan's coast.

## 5.2 CARIBE-EWS

Dr Elizabeth Vanacore reported that Tsunami Information Statements were issued by PTWC for six events during the past year. One of these was located in the western Caribbean with the rest located in the central and south Atlantic. Dr McCreery noted that the 23 January 2021  $M_w$  7.3 in the South Shetland Islands prompted a Tsunami Information Statement for both the CARIBE-EWS and the PTWS. That source region is close to the southernmost parts of Chile and to the Antarctic Peninsula where there are Antarctic stations of several countries. Small tsunami waves were recorded on the Antarctic Peninsula.

## 5.3 IOTWMS

Mr Pattabhi Rama Rao Eluri briefed on two major events of  $M$  6.8 and  $M$  6.9 that occurred off Southern Sumatra on 18 August 2020. For both events, IOTWMS TSPs issued No-Threat bulletins to the Indian Ocean region. He further reported on two significant Pacific events that required Indian Ocean attention. TSP Australia issued a TSP No-Threat bulletin for the Alaska earthquake on 22 July 2020 due to its magnitude estimate reaching 8.0 at one stage. TSP Australia assessed the magnitude as  $M_w$  7.6 for the Loyalty Islands earthquake on 11 February 2021 but issued a TSP No-Threat bulletin by mistake (criteria is to do so only if  $M \geq 8.0$ ). At the national level, JATWC issued a Marine Warning to Lord Howe Island of Australia. Eye-witness reports confirmed a tsunami impact at Lord Howe Island of that level.

## 5.4 NEAMTWS

Dr Francois Schindel  stated that two events in West-Eastern Mediterranean that induced tsunamis occurred during the reporting period. The first one was recorded in May 2020 with a  $M_w$  of 6.5/6.6. The basin was placed on watch advisory level as the earthquake occurred in the subduction zone of southern Crete. The event was recorded by tide gauges with observed tsunami amplitude of 15 cm.

Dr Francois Schindel  continued with the 30 October event with a magnitude close to 7. Many video recordings are available, and run-up was estimated to be around 2 m. A few tide gauges recorded the tsunami several hundred kilometers far from the source but no tide gage were located close the epicenter. He highlighted the importance of the implementation of more sea

level stations to get a more precise forecast system capable of deciphering smaller events. Additional gauge observations are needed to compare the modeling with real data.

Dr Laura Kong intervened and proposed to share a document called 'Post Tsunami Field Survey', related to this event.

## 6. TSUNAMI GLOSSARY UPDATE

Dr Laura Kong reported that the IOC Tsunami Glossary has been updated every three years (2013, 2016, 2019) with the next edition due for publication in 2022. Updates have been proposed by the ITIC, IUGG Tsunami Commission Working Group on Terminology in association with Member States. The IUGG Tsunami Commission and its Working Groups will next meet in July 2021, and it is expected that Glossary revisions will be discussed. Proposed updates are vetted and approved by the TOWS-WG and its Task Teams on Tsunami Watch Operations and Disaster Management and Preparedness.

Currently, the ITIC has identified needed updates to historical tsunami maps and tables as well as one name change for the 1755 Lisbon earthquake to the '1755 Southwest Iberia Margin, Portugal, earthquake'. The IUGG Tsunami Commission Terminology Working Group has also noted that the definitions of several terms can be improved and updated. Lexicon approved by TOWS-WG and recent findings, such as on sea level data sampling requirements, atypical tsunami sources, and Tsunami Ready, should also be added.

**Action 1:** The 2022 edition of the *Tsunami Glossary* should include Tsunami Ready, sea level monitoring and data sampling, and atypically generated tsunamis (i.e. landslides, volcanic eruptions) including graphics and their associated waveforms and periods. Furthermore, out-of-date terminology may require revision (i.e. tsunami intensity).

## 7. IUGG TSUNAMI COMMISSION

Dr Kong reported that the IUGG Tsunami Commission is jointly sponsored by IASPEI (International Association of Seismology and Physics of the Earth's Interior), IAPSO (International Association for the Physical Sciences of the Oceans) and IAVCEI (International Association of Volcanology and Chemistry of the Earth's Interior). It was established at the 12<sup>th</sup> General Assembly of IUGG in Helsinki, Finland, in 1960 to promote the exchange of scientific and technical information about tsunamis among nations concerned with the tsunami hazard. Since then, the Commission has held 28 Tsunami Symposia, both as part of IUGG General Assemblies and independently in alternate years. Further information is made available at <https://tsunamicommission.ipma.pt/home/>.

At the last business meeting held in 2019, the Commission elected new officers.

- Chair: Yuchiro Tanioka (Japan).
- Vice-Chairs: Maria Ana Baptista (Portugal), Diana Greenslade (Australia) and Alexander Rabinovich (Russia).
- Secretary: Mohammad Heidarzadeh, Iran.



There are eight Working Groups as indicated in the table below.

<b>Working Group Name</b>	<b>Chair</b>
Publications	Sasha Rabinovich
Terminology	William Power
Science-based Tsunami Warning	Laura Kong
Tsunami Scenarios	Dmitri Nikolsky
Tsunami Magnitude	Vasily Titov
GNSS Data for Tsunami Warning	Tony Song
Meteotsunami	Ivica Vilibic
Data	Slava Gusiakov

The IOC Secretariat reported that the Chair of the TOWS-WG has formally invited the IUGG Tsunami Commission to be a member of the TOWS-WG, especially noting its relevance for the UN Decade for Ocean Science for Sustainable Development Tsunami Programme.

#### 7.1 IUGG TSUNAMI COMMISSION WORKING GROUP ON SCIENCE-BASED TSUNAMI WARNING

Dr Kong noted that the Terms of Reference for the Science-based Tsunami Warning WG will be to identify and recommend science-based improvements to tsunami warning. The improvements will result in faster, more accurate and more useful warnings to stakeholders and the public. Improvements could cover data networks, monitoring and detection, analysis and threat assessment, forecasting, warning products, and should include consideration of the 'downstream' to ensure that communities and the public will take meaningful action. The WG plans to compile a list of current improvements, relevant peer-reviewed literature and reports, and support activities to improve tsunami warning as part of the UN Decade for Ocean Science for Sustainable Development.

In February 2018 prior to the TOWS-WG-XII, the first UNESCO-IOC Advances in Tsunami Warning to Enhance Community Responses Symposium was held. In the past, the IUGG Joint TC has collaborated with the IOC to hold International Tsunami Symposia, especially in conjunction with ICG/ITSU–PTWS sessions. Should a second symposium be organized, it is proposed that the IUGG Joint Tsunami Commission co-sponsor the event. The IUGG Joint TC WG on Science-based Tsunami Warning may take a lead to help organize the agenda and content, and its WG on Publications take a lead to produce a Special Volume on papers presented at the symposium.

## **8. DEVELOPMENT OF KEY PERFORMANCE INDICATORS IN RELATION WITH SENDAI FRAMEWORK INDICATORS**

Dr McCreery noted that the development of key performance indicators (KPIs) was driven primarily by the TT DMP and any progress would be discussed in their meeting.

Mr Bernardo Aliaga reported that WMO-UNDRR has employed a consultant under the project on building Multi-Hazard Early Warning System (MHEWS) indicators for the Sendai framework, and that UNESCO-IOC has been invited to contribute. He suggested that KPIs for Tsunami Early Warning Systems could be best placed within the broader framework of MHEWS related KPIs for the Sendai Monitoring process.

## **9. LOCAL SOURCE TSUNAMI STANDARD OPERATING PROCEDURES**

The document on local source tsunami standard operating procedures (SOPs) was developed by PTWS with additional inputs coming from IOTWMS. The document on local source tsunamis includes national warnings, official and unofficial warnings, and timing.

**Recommendation 1:** Local source tsunami standard operating procedures should be included as an important component of the UNESCO/IOC Tsunami Ready programme.

## **10. NATIONAL TSUNAMI WARNING CENTRE (NTWC) – COMPETENCY FRAMEWORK**

Dr Kong reported on the status of the NTWC Competency Framework and on training of NTWC staff. The draft Framework was accepted by the PTWS in April 2019 and it continues to be a draft. To provide feedback on the draft, the ITIC conducted a pilot, at the invitation of Tonga in October 2019, where IOC, PTWC, and ITIC trainers trained staff of Tonga Meteorological Service and Geology, and Solomon Islands Meteorological Service. To enable further development, the ITIC will create online and hybrid training under the IOC's Ocean Teacher Global Academy (OTGA). The ITIC will take the lead with Indonesia BMKG as OTGA Specialized Training Centres (STC), and work with TWC practitioners to ensure a meaningful training course that fills the needs of Member State NTWCs. Delivery is planned for 2023 and will include the PTWS NTWC Competency Framework.

More information on the IOC's IODE OTGA Project can be found at <https://classroom.oceanteacher.org> and through the OTGA brochure and presentation that can be found on the TT DMP meeting site ([http://www.ioc-tsunami.org/index.php?option=com\\_oe&task=viewEventDocs&eventID=2894](http://www.ioc-tsunami.org/index.php?option=com_oe&task=viewEventDocs&eventID=2894)). Under the coordination of the UNESCO-IOC Tsunami Unit and in collaboration with Tsunami Information Centres (CTIC, ITIC, IOTIC, NEAMTIC) the STCs will develop seven courses (Tsunami Awareness, Tsunami Ready, Tsunami Early Warning Systems, Tsunami Warning and Emergency Response SOPs, TEMPP, and Tsunami Warning Centre Competencies) through 2023. These training courses will be developed based on the related IOC Manual and Guides and training that have been implemented by the TICs. The complete presentation is part of the meeting documentation.

Mr Eluri informed that the International Training Centre for Operational Oceanography (ITCOcean) established at INCOIS has been designated as the Regional Training Centre by UNESCO-IOC. ITCOcean conducted several training programmes under the aegis of OTGA on different elements of operational oceanography. TSP India jointly with ITCOcean is



interested to host training programmes under the OTGA on the NTWC Competency Framework once online training modules are available.

**Recommendation 2:** Develop standardized trainings that can be delivered online or in person, in particular through the Ocean Teacher Global Academy (OTGA).

## 11. PLANNING FOR THE OCEAN DECADE

Day 2 of the TT TWO meeting commenced with a discussion on the UN Ocean Decade for Sustainable Development, which was led by Dr McCreery. He highlighted the Safe Ocean Decade pillar as of particular relevance to the Task Team.

Mr Bernardo Aliaga recalled the vision ‘*The science we need for the ocean we want*’ and mission ‘*Transformative ocean science solutions for sustainable development, connecting people and our ocean*’ of UN Ocean Decade. The key word here is ‘transformative’. Key milestones include the commencement of the Decade planning process at the 2016/17 UN General Assembly and adoption of UN Ocean Resolution [A/RES/75/239](#) on 31 December 2020. The Resolution ‘*Welcomes the steps taken by the Intergovernmental Oceanographic Commission to prepare the implementation plan for the United Nations Decade of Ocean Science for Sustainable Development (2021–2030) in consultation with Member States, specialized agencies, funds, programmes and bodies of the United Nations, as well as other intergovernmental organizations, non-governmental organizations and relevant stakeholders, and takes note with appreciation of that plan*’. A safe ocean is considered to be one of the seven societal outcomes of the Decade and the 10 challenges include ocean-related risks, ocean observing systems, ocean digital representations.

Ms Christa von Hillebrandt-Andrade, a member of the Executive Planning Group for the UN Decade further commented that the Decade seeks actions that are transformative, audacious and not business as usual. The proposals should seek a step change in the science for sustainable development. Actions need to be inclusive, leaving no one behind, especially SIDS and LDCs. The Tsunami community has the opportunity to do this through programs like SMART and 100% coastal communities vulnerable to tsunamis, as other initiatives that will make everyone safer from the world’s most dangerous waves.

Dr Bruce Howe gave a presentation on SMART cables. The vision is to instrument the oceans and earth with planetary scale networks and sensors, enabled by submarine telecommunication cables, in order to deliver tangible and societal benefits. The Joint Task Force (JTF) consists of 170 members from over 30 countries. Implementing telecommunication cables on a global scale for climate ocean circulations, sea level monitoring, tsunami-earthquake early warning, and disaster risk reduction as well as leveraging the real time network is considered to be an audacious, innovative, and transformative project. The SMART cable initiative has sought endorsement within the Decade Programme.

Mr Mike Angove presented the draft recommendations, which will serve as the Framework for the UNESCO-IOC Tsunami Programme submission for the UN Decade.

### **Recommendation 3:**

**The TOWS WG Task Team on Tsunami Watch Operations (TT TWO) acknowledges** the demonstrated importance and value of existing observational systems including seismometers, coastal tide gauges, and deep ocean tsunameters in monitoring, forecasting and verifying the occurrence of earthquakes and tsunamis to help warn at risk coastal communities around the world;

**The TT TWO notes** that the existing tsunami observing network coverage is in some cases insufficient to deliver necessary global tsunami warning accuracy and timeliness;

**The TT TWO notes with enthusiasm** that the opportunity now exists to leverage new capabilities such as SMART (Scientific Monitoring And Reliable Telecommunications) cable systems, and GNSS-based land deformation data in order to improve tsunami detection, measurement and forecasts particularly in under-observed areas;

**The TT TWO also notes** that that large volumes of topographic and bathymetric data will likely be made available through the Nippon Foundation/General Bathymetric Chart of the Oceans (GEBCO) Seabed 2030 initiative, and that these data are essential for producing more accurate and timely tsunami forecasts to all coastal communities;

**The TT TWO recognizes** that the realization of these gains in tsunami observing and impact forecasting capability will help transform the way threatened populations prepare for, respond to, and recover from potential tsunamis by increasing lead-time time to evacuate and seek protection, reducing uncertainties and unnecessary warnings and evacuations, saving lives and protecting livelihoods;

**The TT TWO also recognizes** that a wide range in National Tsunami Warning Centers capabilities exists, and that this disparity places SIDS and LDCs at higher risk to life and socio economic impact;

**The TT TWO further recognizes** that for the Global Tsunami Warning System to be truly effective it must, to the extent possible, be incorporated within broader Multi-Hazards Early Warning Systems;

**The TT TWO therefore recommends** that the TOWS WG propose a comprehensive Tsunami Programme under the UN Decade of Ocean Science for Sustainable Development (2021–2030) dedicated to achieving transformational advances in tsunami detection, measurement and forecasting, including tsunamis generated by non-seismic sources. **The TT TWO recommends** the Tsunami Programme include **five focus areas related to tsunami warning capability**:

1. Expansion of **existing observational systems** including seismometers, coastal tide gauges, and deep ocean tsunameters to fill identified gaps;
2. Develop and implement **new technologies** to address observational gaps that cannot be covered by existing networks. This would include the widespread deployment of scientific instrumentation on deep-ocean telecommunications cables as developed by the ITU/WMO/UNESCO-IOC Joint Task Force (JTF) SMART Subsea Cables, and GNSS-based applications including both ground motion and atmospheric perturbation detection;
3. Gain **full access** to real-time or near real-time, appropriately calibrated and sampled, sea level, seismic, and GNSS data from existing instruments as well as the relevant tools to utilize these data for the rapid detection and accurate forecasting of tsunamis from all source mechanisms;
4. Increase access and collection of **coastal topographic and bathymetric data**, in collaboration with Seabed 2030, as well as high performance computational capabilities to enable more comprehensive tsunami and other coastal hazard forecasts to better advise community response;

5. 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 threatened by tsunamis and other coastal hazards and are integrated into a **multi hazard framework**.

## 12. UPDATES TO AREA OF SERVICE AND EARTHQUAKE SOURCE ZONE MAPS OF THE ICGS

Dr McCreery recalled the defined Areas of Service and Earthquake Source Zones for the global tsunami warning system, which define when regional TSPs should issue earthquake and/or tsunami products. Only if an event outside of the defined region presents a threat to a coast within the ICG, the TSPs will issue products for outside of their normal area. Dr McCreery acknowledged that the maps have served well and noted a couple of changes will be suggested via email.

**Recommendation 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.

## 13. HANDLING OF TSUNAMIS FROM NON-SEISMIC-SOURCES AND NON-SUBDUCTION ZONE EARTHQUAKES

Dr Francois Schindel  reported on the activities of the team on Atypical tsunami sources undertaken in 2020. He thanked all the team members who contributed with relevant text and references. A preliminary report was produced in 2020 and circulated to the TT TWO members in January 2021.

Three main topics were presented: (1) Non mega thrust earthquakes; (2) other geophysical sources (landslides, volcanoes); and (3) Meteotsunami. Dr Schindel  highlighted the need to take all tsunami source types into account as they can pose a serious threat to coastal populations.

The meteotsunami chapter has been finalized. The two other chapters will contain additional information related to the current volcano and landslides monitoring and warning systems as well as the detection and fast characterization of non mega thrust earthquakes. Near field and far field issues and solutions should be highlighted.

**Action 2:** Prepare the final report on atypical tsunami sources for presentation the 2022 TT TWO meeting.

Dr Wilfried Strauch noted that in Nicaragua, Central America, there are two situations (in oceans and lakes) where volcanoes can and have generated tsunamis. These are rare events, however, with population growth in these areas the risk is increasing.

The presentation on Splay Faulting in the Makran subduction zone by Dr Mohammed Mokhtari was noted as a contribution to this agenda item.

## 14. PRODUCTS FOR THE MARITIME COMMUNITY

Dr McCreery explained that in recent years there have been proposals from the TOWS-WG to the World-Wide Navigational Warning Service Sub-Committee (WWNWS-SC) on how these products for the maritime community could look (i.e. message content and thresholds for sending them) and ICGs were asked to consider the implementation of such products. The proposal on TSP Messages for the Maritime Community was approved at the 12<sup>th</sup> session of

TOWS-WG, which requested the ICGs to consider the proposal for implementation in their respective basins. (Refer to [TOWS-WG-XII, Appendix 4 to Annex IV.](#))

Mr Pattabhi Rama Rao Eluri reported that TSP Australia has implemented the Maritime message templates. TSP India and TSP Indonesia are currently working towards implementation. These messages and templates will be reviewed by IOTWMS WG 2 in upcoming meetings to adopt in service definition document. There is a need of some direction on who to announce to IHO/IMO and maritime users' subscription methodology.

Mr Chris Janus, Chair of the WWNWS, provided comments on the topic of maritime messaging. He began by recognizing the importance of coordination, appreciating that links and relationships were being developed amongst different institutions. He also reiterated the importance of conveying information from a TSP in a format which is easy for maritime coordinators to process and distribute, and in a template that is then easily processed by ships. He suggested sharing the map with NAVAREA coordinators so that they can understand which TSPs would contact them if a particular event triggers a tsunami. It would be useful to building relationships and information flows with TSPs. He mentioned that creating a format for tsunami warning as a navigational hazard would be useful, as indicators would appear on electronic charts, thereby interacting with ship positions.

Dr Charles McCreery noted that the two US tsunami centres are revamping their messaging software and adding this type of messaging code will be possible. He reported that in a recent meeting of the four PTWS TSPs the subject of Maritime Messages was discussed but that none have yet implemented those products.

With regards to maritime products for TSPs in the NEAM region, Dr Schindel  explained that this is not a useful region in which to test technology because tsunamis are usually below 30 cm (with the exception of Greece). As such, he suggested that new transmission messages should be tested in the Pacific region first, and only applied to the Mediterranean region later when there is agreement on a specific type of content for messaging.

In regard to positive experiences from Wave exercises, Mr Aliaga noted that it would be useful to regularly share with TSPs the lists of updated NAVAREAS focal points.

## 15. GLOBAL SERVICE DEFINITION DOCUMENT

Dr Francois Schindel  highlighted the changes incorporated in section 4.7 (models), 4.8 (standard operating procedures), etc. of the Global Service Definition Document (GSDD). Other additions proposed to be incorporated by the IOC Secretariat are listed in the contents section of the revised GSDD. Any changes to the roles and responsibilities of NTWCs should take into careful consideration the status in different ICGs.

**Action 3:** Update the Global Service Definition Document (GSDD) during the inter-sessional period and submit for approval at the 2022 TOWS-WG meeting.

**Recommendation 5:** Review the GSDD at each TT TWO meeting with a view to publish a new version every 3 years, when necessary.

## 16. OTHER ISSUES

### 16.1 WORLD TSUNAMI AWARENESS DAY ACTIVITIES

Mr Pattabhi Rama Rao Eluri briefed on World Tsunami Awareness Day (WTAD) activities in the Indian Ocean. IOTWMS actively participated in WTAD 2020 in coordination with the UNESCO-IOC Tsunami Unit in November 2020. IOTIC in collaboration with IOTWMS Secretariat organized a Regional Webinar on Tsunami Ready in Indian Ocean Island States. In addition, a number of Member States and IOTIC were active in social media campaign during the WTAD.

IOTWMS will continue to take part in WTAD activities in 2021 and will align with the theme of WTAD in 2021 related to Target F in Sendai Framework for DRR related to International Collaboration for Development which we believe that these are strongly related to the IOTWMS activities both on the tsunami warning system as well as on tsunami ready.

Mr Bernardo Aliaga reported that Mr Denis McClean, Head of communications of UNDRR, is attending the TT DMP meeting and that Task Team will provide suggestions for TOWS-WG on WTAD 2021. The focus of target 7 'Multi-hazard early warning systems' will be on technology transfer for developing countries. In cooperation with UNDRR, one of the elements organized could be on National Tsunami Warning Centers and associated technology transfer.

### 16.2 NEXT SYMPOSIUM

Dr Francois Schindel  presented a proposal for the next tsunami symposium. The co-chairmanship from Mr David Coetzee (TT DMP) has been confirmed.

The provisional date for the symposium is 2022, serving as the first UNESCO-IOC Symposium during the 2021–2030 Decade of Ocean Science. Two other symposiums are expected to be organized in 2026 (mid-term) and 2030 (end of the decade).

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 proposed action items include:

1. Review the latest and potential new technologies and procedures for estimating tsunami threat and test their suitability and feasibility for providing more timely and accurate warnings.
2. Consider ways of estimating uncertainties associated with threat assessments and optimal ways of conveying these uncertainties to decision-makers.
3. Examine ways of utilizing enhanced tsunami threat information in making decisions with regards to emergency responses.
4. Provide information on the latest technologies for disseminating tsunami warning information to responders and communities.
5. Formulate roadmaps for developing and implementing new technologies, procedures, and their application to enable more effective community responses to tsunami threats.

6. Explore lessons and practice with regards to the uptake and implementation of the Tsunami Ready Programme.
7. Explore lessons of the COVID pandemic impact on the Tsunami Watch operation and Tsunami evacuation/drill process.

**Recommendation 6:** In regard to the next Tsunami Symposium, incorporate more diversity in the organizing 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.

### 16.3 SEA LEVEL NETWORKS

Dr Schindelé reiterated that the 2020 recommendation on sea level instruments remains valid. Specifically, increasing sampling rate to one sample per second is recommended for more accurate recording of sea level time series for tsunami detection, especially from non-seismic source tsunamis.

Dr McCreery noted the importance of ensuring the accurate response of sea-level gauges. He pointed out that readings from these gauges are used not only to monitor tsunami impacts but to validate forecasts. Gauges that appear to be operating and calibrated correctly because they show normal tidal oscillations may not respond the same to much higher frequency tsunami oscillations due to the response of a stilling well or low-pass filtering in the data logger. He suggested there needs to be some guidance regarding routine calibration of sea level gauges for tsunami-period signals to ensure readings accurately reflect those signals.

Dr Vanacore pointed out that many gauges are in remote locations making routine calibrations more difficult.

**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.

## 17. RECOMMENDATIONS AND ACTIONS FOR REPORTING TO TOWS-WG

### 17.1 RECOMMENDATIONS

**Recommendation 1:** Local source tsunami standard operating procedures should be included as an important component of the UNESCO-IOC Tsunami Ready programme.

**Recommendation 2:** Develop standardized trainings that can be delivered online or in person, in particular through the Ocean Teacher Global Academy (OTGA).

**Recommendation 3: The TOWS WG Task Team on Tsunami Watch Operations (TT TWO) acknowledges** the demonstrated importance and value of existing observational systems including seismometers, coastal tide gauges, and deep ocean tsunameters in monitoring, forecasting and verifying the occurrence of earthquakes and tsunamis to help warn at risk coastal communities around the world;

**The TT TWO notes** that the existing tsunami observing network coverage is in some cases insufficient to deliver necessary global tsunami warning accuracy and timeliness;

**The TT TWO notes with enthusiasm** that the opportunity now exists to leverage new capabilities such as SMART (Scientific Monitoring And Reliable Telecommunications) cable systems, and GNSS-based land deformation data in order to improve tsunami detection, measurement and forecasts particularly in under-observed areas;

**The TT TWO also notes** that that large volumes of topographic and bathymetric data will likely be made available through the Nippon Foundation/General Bathymetric Chart of the Oceans (GEBCO) Seabed 2030 initiative, and that these data are essential for producing more accurate and timely tsunami forecasts to all coastal communities;

**The TT TWO recognizes** that the realization of these gains in tsunami observing and impact forecasting capability will help transform the way threatened populations prepare for, respond to, and recover from potential tsunamis by increasing lead-time time to evacuate and seek protection, reducing uncertainties and unnecessary warnings and evacuations, saving lives and protecting livelihoods;

**The TT TWO also recognizes** that a wide range in National Tsunami Warning Centers capabilities exists, and that this disparity places SIDS and LDCs at higher risk to life and socio economic impact;

**The TT TWO further recognizes** that for the Global Tsunami Warning System to be truly effective it must, to the extent possible, be incorporated within broader Multi-Hazards Early Warning Systems.

**The TT TWO therefore recommends** that the TOWS WG propose a comprehensive Tsunami Programme under the UN Decade of Ocean Science for Sustainable Development (2021-2030) dedicated to achieving transformational advances in tsunami detection, measurement and forecasting, including tsunamis generated by non-seismic sources. **The TT TWO recommends** the Tsunami Programme include **five** focus areas **related to tsunami warning capability**:

1. Expansion of **existing observational systems** including seismometers, coastal tide gauges, and deep ocean tsunameters to fill identified gaps;
2. Develop and implement **new technologies** to address observational gaps that cannot be covered by existing networks. This would include the widespread deployment of scientific instrumentation on deep-ocean telecommunications cables as developed by the ITU/WMO/UNESCO-IOC Joint Task Force (JTF) SMART Subsea Cables, and GNSS-based applications including both ground motion and atmospheric perturbation detection;
3. Gain **full access** to real-time or near real-time, appropriately calibrated and sampled, sea level, seismic, and GNSS data from existing instruments as well as the relevant tools to utilize these data for the rapid detection and accurate forecasting of tsunamis from all source mechanisms;
4. Increase access and collection of **coastal topographic and bathymetric data**, in collaboration with Seabed 2030, as well as high performance computational capabilities to enable more comprehensive tsunami and other coastal hazard forecasts to better advise community response;
5. Ensure all **National Tsunami Warning Centres** have **access to data, tools and communication platforms, protocols and competencies** to timely and effectively warn coastal and maritime communities threatened by tsunamis and other coastal hazards and are integrated into a **multi hazard framework**.

**Recommendation 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.

**Recommendation 5:** Review the GSSD at each TT TWO meeting with a view to publish a new version every 3 years, when necessary.

**Recommendation 6:** Organize the second UNESCO-IOC Tsunami Symposium in 2022 to support the further development of the tsunami warning and mitigation systems to enable enhanced community responses; establish a diverse organizing 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.

## 17.2 ACTIONS

**Action 1:** The 2022 edition of the Tsunami Glossary should include Tsunami Ready, sea level monitoring and data sampling, and atypically generated tsunamis (i.e. landslides, volcanic eruptions) including graphics and their associated waveforms and periods. Furthermore, out-of-date terminology may require revision (i.e. tsunami intensity).

**Action 2:** Prepare the final report on atypical tsunami sources for presentation the 2022 TT TWO meeting.

**Action 3:** Update the Global Service Definition Document (GSSD) during the inter-sessional period and submit for approval at the 2022 TOWS-WG meeting.

**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.

## 18. CLOSE OF MEETING

Dr McCreery thanked the participants for their contributions to a highly productive discussion and closed the meeting at 2:00 pm UTC on 23 February 2021.



APPENDIX 1

**PROVISIONAL AGENDA AND TIMETABLE**

MEETING OF THE TOWS WG INTER-ICG TASK TEAM  
ON TSUNAMI WATCH OPERATIONS (TT TWO)

22–23 February 2021 (Online)

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 Schindel�	France	Centre National d'alerte aux Tsunamis Centre Polyn�sien de Pr�vention des Tsunamis	NEAMTWS PTWS
Fernando Carrilho	Portugal	Portugese 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

Day 1: Monday, February 22, 2021, 1200-1400 UTC

Item	Time	Topic	Reference	Lead
1	1200-1205	<b>Session Organization</b> Logistics, participants, agenda		Chip McCreery
2	1205-1220	<b>Review Action Items from the Previous TT TWO Meeting</b>	TOWS-WG, 13th Meeting Report, Annex IV, page 15	Chip McCreery ICG Representatives

Item	Time	Topic	Reference	Lead
3	1220-1240	<b>Status of Implementation of the TOWS-WG Requests to the TT TWO</b>	TOWS-WG, 13th Meeting Report, Annex II	Chip McCreery ICG Representatives
4	1240-1300	<b>Tsunami Watch Operations</b>  Current Status and Plans in all ICGs		TTTWO ICG Representatives
5	1300-1320	<b>Significant Operational Events Since Last Meeting</b>		TTTWO ICG Representatives
6	1320-1330	<b>Tsunami Glossary Update</b>		TTTWO with Input from  TTDMP
7		<b>IUGG Tsunami Commission recent activities</b>		Laura Kong
8	1330-1340	<b>Development of KPIs in relation with Sendai Framework Indicators</b>	TOWS-WG, 13th Meeting Report, Annex III, page 3, Annex IV, page 6	TTTWO with Input from TTDMP
9	1340-1350	<b>Local Source Tsunami SOPs</b>  – best practice for warning and response	TOWS-WG, 13th Meeting Report, Annex III, page 3, Annex IV, page 6	TTTWO with Input from TTDMP
10	1350-1400	<b>NTWC Competency Framework</b>	TOWS-WG, 13th Meeting Report, Annex III, page 4, Annex IV, page 7	TTTWO with Input from TTDMP
End of Day 1				

Day 2: Tuesday, February 23, 2021, 1200-1400 UTC

Item	Time	Topic	Reference	Lead
11	1200-1220	<b>Planning for the Ocean Decade</b>	TOWS-WG, 13th	TTTWO with Input from TTDMP

Item	Time	Topic	Reference	Lead
			Meeting Report, Annex III, page 4 Annex IV, page 8	
12	1220-1230	<b>Updates to Area of Coverage and ESZ Maps of the ICGs</b>	TOWS-WG, 13th Meeting Report, Annex IV, page 9	TTTWO ICG Representatives
13	1230-1300	<b>Handling of Tsunamis from Non-Seismic Sources and Non-subduction Zone Earthquakes</b>	TOWS-WG, 13th Meeting Report, Annex IV, Section 12, page 10-11	Francois Schindelé TTTWO ICG Representatives
14	1300-1310	<b>Products for Maritime Community</b>	TOWS-WG, 13th Meeting Report, Annex IV, page 10	TTTWO ICG Representatives
15	1310-1320	<b>Update to the Global Service Definition Document</b>	TOWS-WG, 13th Meeting Report, Annex IV, page 11	Francois Schindelé TTTWO ICG Representatives
16	1320-1345	<b>Other Issues</b> <ul style="list-style-type: none"> <li>• WTAD Activities</li> <li>• Next Symposium</li> <li>• Sea Level Networks</li> </ul>	TOWS-WG, 13th Meeting Report, Annex IV, page 11	TTTWO ICG Representatives
17	1350-1400	<b>Recommendations and Actions for Reporting to the TOWS WG, Closing</b>		Chip McCreery IOC-Representative
Meeting Close				

## APPENDIX 2

### LIST OF PARTICIPANTS

#### MEETING OF THE TOWS WG INTER-ICG TASK TEAM ON TSUNAMI WATCH OPERATIONS (TT TWO)

22 – 23 February 2021 (Online)

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Picture of participants – Day 1



Picture of participants – Day 2





**APPENDIX 3**

**SIGNIFICANT OPERATIONAL EVENTS  
IN THE INTER-SESSIONAL PERIOD**

MEETING OF THE TOWS WG INTER-ICG TASK TEAM  
ON TSUNAMI WATCH OPERATIONS (TT TWO)

22–23 February 2021 (Online)

Date	Place	Mw Initial	Mw GCMT	Mw USGS	System	Center	Action/Alert	Amp
05/01/20	Puerto Rico Region	5.6	-	-	NEAMTWS	IPMA	Information	-
07/01/20	Puerto Rico Region	6.3	6.4	6.4	NEAMTWS	IPMA	Information	-
07/01/20	Puerto Rico Region	5.8	5.8	5.8	NEAMTWS	IPMA	Information	-
11/01/20	Puerto Rico Region	5.8	5.9	5.9	NEAMTWS	IPMA	Information	-
28/01/20	Dodecanese Islands, Greece	5.7	5.5	5.5	NEAMTWS	KOERI	Information	-
30/01/20	Dodecanese Islands, Greece	6.1	5.5	5.5	NEAMTWS	KOERI	ADVISORY	-
30/01/20	Dodecanese Islands, Greece	5.8	5.8	5.7	NEAMTWS	KOERI	Information	-
		5.9	5.8	5.7		INGV	Information	-
		5.9	5.8	5.7		NOA	Advisory	-
18/02/20	Svalbard	5.6	5.5	-	NEAMTWS	CENALT	Information	-
21/03/20	Albania Border Region	5.8	5.7	5.7	NEAMTWS	KOERI	Information	-
		5.8	5.7	5.7		INGV	Information	-
02/05/20	Southern Crete	6.0	6.6	6.5	NEAMTWS	NOA	Advisory	
		6.5	6.6	6.5		NOA	Watch	0.16m

Date	Place	Mw Initial	Mw GCMT	Mw USGS	System	Center	Action/Alert	Amp
		6.7	6.6	6.5		INGV	Watch	0.15m
		6.7	6.6	6.5		KOERI	Advisory	
		6.7	6.6	6.5		KOERI	Watch	0.14m
20/05/20	Greece	5.9	5.7	-	NEAMTWS	NOA	Information	-
		5.7	5.7	-		INGV	Information	-
		5.7	5.7	-		KOERI	Information	-
30/05/20	Northern Mid-Atlantic Ridge	5.7	5.6	5.5	NEAMTWS	IPMA	Information	-
		5.7	5.6	5.5		CENALT	Information	-
20/06/20	Iceland Region	5.6	5.4	5.4	NEAMTWS	CENALT	Information	-
20/06/20	Iceland Region	5.6	5.7	5.7	NEAMTWS	CENALT	Information	-
21/06/20	Iceland Region	5.6	6.0	6.0	NEAMTWS	IPMA	Information	
		5.8	6.0	6.0		CENALT	Information	-
30/08/20	Central Mid-Atlantic Ridge	6.3	6.5	6.5	NEAMTWS	CENALT	Information	-
		6.4	6.5	6.5		IPMA	Information	-
06/09/20	Central Mid-Atlantic Ridge	6.4	6.6	6.7	NEAMTWS	IPMA	Information	-
		6.4	6.6	6.7		CENALT	Information	-
17/09/20	Central Mid-Atlantic Ridge	5.5	5.8	5.7	NEAMTWS	CENALT	Information	-
18/09/20	Central Mid-Atlantic Ridge	6.6	6.9	6.9	NEAMTWS	IPMA	Information	-
		6.6	6.9	6.9		CENALT	Information	-



Date	Place	Mw Initial	Mw GCMT	Mw USGS	System	Center	Action/Alert	Amp
18/09/20	Creete-Greece	5.8	6.1	5.9	NEAMTWS	INGV	Information	-
		5.8	6.1	5.9		KOERI	Information	-
		5.8	6.1	5.9		NOA	Advisory	-
03/10/20	Eastern Greenland	5.5	5.3	5.3	NEAMTWS	CENALT	Information	-
12/10/20	Creete, Greece	5.5	5.3	5.2	NEAMTWS	NOA	Advisory	-
20/10/20	Iceland Region	5.6	5.6	5.6	NEAMTWS	CENALT	Information	-
30/10/20	Northern Mid Atlantic Ridge	5.7	5.9	5.9	NEAMTWS	CENALT	Information	-
30/10/20	Aegean Sea Dodecanese Islands	6.6	7.0	7.0	NEAMTWS	NOA	Watch	0.15m
		7.0	7.0	7.0		INGV	Watch	0.08m
		7.0	7.0	7.0		KOERI	Watch	*
30/10/20	Jan Mayen Islands Region	5.6	5.6	-	NEAMTWS	IPMA	Information	-
		5.8	5.6	-		CENALT	Information	-
14/12/20	Norwegian Sea	6.0	5.9	5.8	NEAMTWS	IPMA	Information	-
		5.7	5.9	5.8		CENALT	Information	-

(\* Koeri Message refers non specified seal level readings and eyewitness observation reports)

## APPENDIX 4

### **RECOMMENDATIONS AND ACTIONS FROM THE LAST TTTWO MEETING HELD IN 2020**

#### MEETING OF THE TOWS WG INTER-ICG TASK TEAM ON TSUNAMI WATCH OPERATIONS (TT TWO)

22–23 February 2021 (Online)

#### **RECOMMENDATIONS**

Recommendation 1: Recommends ICGs to discuss procedures and best practices for local source tsunami SOPs drawing upon the guidelines provided by PTWS and subsequent inputs by the IOTWMS.

Recommendation 2: Recommends to use the draft PTWS National Tsunami Warning Centre Competency Framework in designing online and onsite training courses planned under the Ocean Teacher Global Academy (OTGA).

Recommendation 3: Recommend broader sharing of seismic, sea level, and other data types that support tsunami warning and analysis capabilities per the IOTWMS ICG document on the need for enhanced data sharing.

Recommendation 4: Recommend the following changes to the AoS Map:

- PTWS: Include AoS of South China Sea Tsunami Advisory Centre (SCSTAC) in line with recommendations of the ICG/PTWS XXVIII, noting that NWPTAC no longer provides service for this area.
- NEAMTWS: Status of IPMA to be modified from Candidate TSP to Accredited TSP.

Recommendation 5: Recommend that in order to record tsunamis from non-subduction earthquake sources as well as non-seismic sources a sample rate of 1 sample/sec or higher be implemented on sea level gauges.

Recommendation 6: Recommends to extend the tenure of the Task Team on Tsunami Watch Operations for a further term with the same Terms of Reference.

#### **ACTIONS**

Action 1: Team comprising Sarah-Jayne McCurrach (PTWS), Yuelong Miao and Harkunti Rahayu (IOTWMS), Elizabeth Vanacore and Mary Regifo (CARIBE-EWS), and Ocal Necmioglu (NEAMTWS) to complete work on harmonised performance monitoring framework including data collection tools/questionnaire and reporting formats for presentation to the next TOWS meeting.

Action 2: Noting the importance of CAP for provision of harmonised tsunami warnings, requests IOTWMS to make a presentation to the next meeting of the Task Team on use of CAP.

Action 3: IOC Secretariat to explore the possibility of providing links to TSP websites on the IOC TSU Webpage.

Action 4: IOC Secretariat to provide links to important tsunami related documents and technical manuals in a readily accessible web page on the IOC TSU programme.

Action 5: Francois Schindel  and IOC Secretariat to finalize changes to the Global Service Definition Document for consideration at the next meeting.

Action 6: Appreciating the presentations on non-megathrust and aseismic source tsunamis, requests the ad-hoc team comprising Yuji Nishimae, Francois Schindel , Weniza, Jacopo Selva, David Coetze, Valerie Clouard, Elizabeth Vanacore, and Ivica Vilbic to prepare a document on best practices for hazard assessment, monitoring and responding to tsunamis from those sources for the next TOWS meeting.

APPENDIX 5

**LIST OF ACRONYMS**

MEETING OF THE TOWS WG INTER-ICG TASK TEAM  
ON TSUNAMI WATCH OPERATIONS (TT TWO)

22–23 February 2021 (Online)

<b>CAP</b>	Common Alerting Protocol
<b>CARIBE WAVE</b>	Caribbean Wave Exercise
<b>CARIBE-EWS</b>	Tsunami and Other Coastal Hazards Warning System for the Caribbean and Adjacent Regions
<b>CATAC</b>	Central American Tsunami Advisory Centre
<b>CENALT</b>	Centre National d'Alerte aux Tsunamis
<b>DART</b>	Deep-ocean Assessment and Reporting of Tsunamis
<b>DG-ECHO</b>	Directorate-General for European Civil Protection and Humanitarian Aid Operations
<b>GEBCO</b>	General Bathymetric Chart of the Oceans
<b>GSSD</b>	Global Service Definition Document
<b>GTS</b>	Global Telecommunication System
<b>IAPSO</b>	International Association for the Physical Sciences of the Oceans
<b>IASPEI</b>	International Association of Seismology and Physics of the Earth's Interior
<b>IAVCEI</b>	International Association of Volcanology and Chemistry of the Earth's Interior
<b>ICG</b>	Intergovernmental Coordination Group
<b>INGV</b>	Istituto Nazionale di Geofisica e Vulcanologia, Italy
<b>IOC</b>	Intergovernmental Oceanographic Commission
<b>IODE</b>	International Oceanographic Data and Information Exchange
<b>IOTIC</b>	Indian Ocean Tsunami Information Centre
<b>IOTWMS</b>	Indian Ocean Tsunami Warning and Mitigation System
<b>IPMA</b>	Portuguese Institute of the Sea and the Atmosphere
<b>ITIC</b>	International Tsunami Information Centre
<b>IUGG</b>	International Union of Geodesy and Geophysics
<b>JMA</b>	the Japan Meteorological Agency

<b>KOERI</b>	Kandilli Observatory and Earthquake Research, Turkey
<b>KPI</b>	Key Performance Indicator
<b>MHEWS</b>	Multi-Hazard Early Warning System
<b>NAVAREA</b>	Navigational Area (within the World Wide Navigational Service)
<b>NEAM</b>	North-Eastern Atlantic, the Mediterranean and Connected Seas
<b>NEAMTWS</b>	North-Eastern Atlantic and Mediterranean Tsunami Early Warning and Mitigation System
<b>NOA</b>	National Observatory of Athens, Greece
<b>NTWC</b>	National Tsunami Warning Centre
<b>NWPTAC</b>	Northwest Pacific Tsunami Advisory Center
<b>OTGA</b>	Ocean Teacher Global Academy
<b>PTWS</b>	Pacific Tsunami Warning and Mitigation System
<b>SCSTAC</b>	South China Sea Tsunami Advisory Center
<b>SOP</b>	standard operating procedures
<b>STC</b>	Specialized Training Centres
<b>SVG</b>	Saint Vincent and the Grenadines
<b>TOWS-WG</b>	Working Group on Tsunamis and Other Hazards related to Sea-Level Warning and Mitigation Systems
<b>TSP</b>	Tsunami Service Provider
<b>TSU</b>	IOC Tsunami Programme
<b>TT TWO</b>	Task Team on Tsunami Watch Operations
<b>UNDRR</b>	United Nations Office for Disaster Risk Reduction
<b>UNESCO</b>	United Nations Educational, Scientific and Cultural Organization
<b>USGS</b>	United States Geological Survey
<b>WMO</b>	World Meteorological Organization
<b>WTAD</b>	World Tsunami Awareness Day
<b>WWNWS-SC</b>	World-Wide Navigational Warning Service Sub-Committee

ANNEX IV

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

22–23 February 2021 (Online)

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**IOC Secretariat**

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Denis Chang Seng	IOC/NEAMTIC (Secretariat)
Nora Gale	ICG/IOTWMS Secretariat
Jiuta Korovulavula	IOC Secretariat
Salim Slaoui	IOC Secretariat, intern
Celine Tiffay	IOC Secretariat, intern

**1. OPENING AND MEETING ORGANIZATION**

The Chairperson, Mr David Coetzee, welcomed all members and participants to the TOWS-WG-XIV Task Team on Disaster Management and Preparedness (TT DMP). Mr Denis Chang Seng, IOC Programme Specialist and Technical Secretary, provided brief information and virtual meeting logistics.

**2. REFLECTION ON TT REPORT TO TOWS-WG-XIII (2020)**

The Chairperson introduced the provisional Agenda. The Group adopted the Provisional Agenda with no change. The meeting reflected on the recommendations of the Task Team to [TOWS-WG-XIII](#). The Chairperson noted the meeting agenda reflected the recommendations from last year, which would be further discussed throughout the two days sessional meetings.

### **3. REVISIT TT DMP RECOMMENDATIONS TO TOWS-WG IN 2020**

#### **3.1 WAVE EXERCISES**

The Chairperson noted that the TT DMP in 2020 recommended increased coordination between ICGs (in particular the Pacific and Indian Ocean regions) for wave exercises. He requested ICGs to report on wave exercises and recommendations concerning exercise coordination.

##### **3.1.1 Intergovernmental Coordination Group for the Tsunami and other Coastal Hazards Warning System for the Caribbean and Adjacent Regions (ICG/CARIBE EWS)**

Caribe Wave 2020 occurred on 19 March 2020 and its execution was scaled back from full-scale to a Communications Test by the Regional Tsunami Service Provider (PTWC). The number of participants in Caribe Wave 2020 has reduced from 800,000 in 2019 to 4,622. The significant reduction in number reflects the onset of the pandemic. Caribe Wave 2021 is scheduled for 11 March 2021 with two scenarios (Jamaica and Northern Lesser Antilles). From the onset, the pandemic situation was considered. Preparations are on track with registration, webinars and promotion of virtual Table Top exercises, other virtual and COVID safe activities. A special focus are the use of alternate communication systems like WMO/GTS/WIS and GEONETCast Americas and HRIT/EMWIN with the collaboration of WMO and NOAA. Some 33,000 persons have registered so far on <https://www.tsunamizone.org/> and efforts are underway to increase participation through promotion and upcoming webinars.

##### **3.1.2 Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWMS)**

Amidst the COVID-19 situation, Indian Ocean Member States agreed to proceed in conducting IOWave20 exercise. The IOWave20 used three scenarios and conducted exercise on three different days, 6, 13, and 20 October 2020. The IOWave20 Task Team published the exercise manual on 7 May 2020. The IOTIC and the ICG/IOTWMS Secretariat organized a pre-IOWave20 Webinar on Standard Operation Procedures in September. Twenty-three Indian Ocean Member States participated in the IOWave exercise. Five countries participated using the 3 scenarios, 3 countries used 2 scenarios, and the remaining exercise only using 1 scenario that most impacted the country. The exercise varied from Table Top Exercise, Orientation, Functional and 5 countries involved the communities. A post IOWave20 Webinar was held in November 2020 organized by IOTIC and the ICG/IOTWMS secretariat.

##### **3.1.3 Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System (ICG/PTWS)**

A PacWAVE exercise took place in 2020 in the Pacific region. Although it was originally envisioned as a downstream type of exercise, due to COVID-19 it was scaled back to only a communications exercise on the World Tsunami Awareness Day (in November 2020), with countries choosing to conduct any further exercises at their own discretion. A few regional exercises were also conducted in Central America and South America. Some countries also had Table Top or downstream exercises, but these were optional.

The ICG/PTWS and Steering Committee have not been able to meet due to the COVID-19 pandemic (other than to decide to scale back PacWAVE 20 and postpone the ICG); as such, there has not been any discussions about the next PacWAVE, although as it stands it will probably take place in 2022 (following the schedule of every two years).

### 3.1.4 Intergovernmental Coordination Group for the Tsunami Early Warning and Mitigation System in the North-Eastern Atlantic, the Mediterranean and Connected Seas (ICG/NEAMTWS)

Countries in the North-Eastern Atlantic, Mediterranean and Connected Seas (the NEAM region) will participate in a tsunami test and response exercise from 8 to 10 March 2021. NEAMwave21 will coincide with the 10th commemoration of 11 March 2011 Tohoku Earthquake and Tsunami. NEAMWave21 will carry out three scenario exercise simulations. Key achievements in preparing for NEAMWave21 is the collaboration between TSPs to prepare two joint scenarios to simplify the exercise and the preparation of online platforms and forms for subscription and exercise evaluation. Member States are being encouraged to extend exercises to community level where appropriate, if national sanitary measures related to COVID-19 pandemic allow.

The Group noted that exercises in the Pacific and in the Indian Ocean should be organized and coordinated in alternate years to avoid overlap. The PTWS organized the PACWave20 in November 2020 and IOTWMS organized the IOWave20 in October.

The Group also noted that there has not been any ICG meetings in the PTWS, IOTWMS and NEAMTWS. The Group noted that the inter ICG Wave Exercise workshop has not yet been organized.

#### Recommendations to TOWS-WG

**Notes** that due to the COVID-19 pandemic the WAVE exercises workshop has not yet convened, and that CARIBEWAVE, PACWAVE, IOWAVE, and NEAMWAVE exercises did take place in 2020, and planning for future exercise is pending or underway;

**Requests** the Secretariat to organize a virtual meeting on WAVE exercises to improve coordination, so as to minimize timing conflicts, share best practices for exercise evaluation and the use of online tools; and

**Agrees** to share outcomes, lessons learned of regional exercises with relevant ICG Working Groups.

### 3.2 TSUNAMI RISK MANAGEMENT

In the NEAM region, the Joint Research Center (JRC) of the European Commission has implemented Last Mile projects in Kos (Greece) and Bodrum (Turkey) from 2019-2020. The project included the determination of tsunami inundation and development of tsunami evacuation maps; installation of a local earthquake-tsunami monitoring system, awareness, and preparations activities (seminars etc.). JRC is now running a second phase of the Last Mile project with similar deliverables in partnership with the Civil Protection Agency and Malta University in Marsaxlokk town, Malta. A tsunami drill was planned as part of NEAMWave21 exercise, however the exercise will be limited to a functional drill because of the ongoing pandemic.

The NEAMTWS Secretariat has recently submitted a project proposal with DG-ECHO. The main objective of the project will be to strengthen the resilience of vulnerable coastal communities in North-Eastern Atlantic, Mediterranean Tsunami Warning System (NEAMTWS) countries to tsunamis and other sea level-related hazards. The project will be implemented through three components: (1) Adapt Global Tsunami Ready Standards and Guidelines and pilot Tsunami Ready within the framework of the NEAMTWS; (2) supply and install tsunami detection and alerting equipment in selected NEAMTWS countries; and (3) evaluate the effectiveness, compatibility, performance and benefits of the "Inexpensive Device for Sea Level" (IDSL) network in NEAMTWS countries and secure its sustainability. NEAMTWS



countries that are expected to benefit from this project includes Cyprus, Egypt, Greece, Malta, Morocco, Spain, and Turkey. In Greece and Turkey, the project aims to build on the first phase of the Last Mile Project and establish pilot Tsunami Ready communities. A summary of the project will be shared via the Task Team meeting site.

### 3.3 PERFORMANCE INDICATORS

Key Performance Indicators (KPIs) frameworks exist in several ICGs. ICG/NEAMTWS has its own interim KPI for upstream components. It was informally tested /applied for the first time following the recent Samos-Izmir tsunami on 30 October 2020. In IOTWMS, the KPI is based on three key pillars. In the ICG/PTWS region, the KPI includes a fourth pillar related to international cooperation. There is a need to better coordinate this work on KPI in all the ICG regions.

The Group agreed to maintain the international cooperation and development component of the KPI because it integrates and relates with the Sendai Framework for Disaster Risk Reduction. The Group underlined not to drop the international cooperation component because it is also related to the WTAD theme/target this year. The Task Team highlighted that the Inter-ICG KPIs should facilitate Member States to develop their own KPIs.

IOC is working closely with the WMO DRR group/programme regarding the Sendai Framework for Disaster Risk Reduction, in particular in relation to the Multi-Hazard Early Warning Systems. The KPI framework should have a multi-hazard approach.

#### **Recommendations to TOWS-WG**

**Notes** that the PTWS is the only ICG with International Cooperation indicators and the theme of the World Tsunami Awareness Day 2021 will link with the target F of the Sendai Framework for DRR (2015-2030) on International cooperation to developing countries;

**Recommends** that the CARIBE-EWS, IOTWMS, and NEAMTWS to strongly consider including International Cooperations in their Key Performance Indicators (KPIs);

**Recommends** that the Task Team on KPIs complete the work on harmonized performance monitoring framework including data collection tools/questionnaire and reporting formats for presentation to the next TOWS meeting;

**Requests** the Secretariat to arrange a virtual meeting of the Task Team on KPIs in the near future to discuss a work plan.

### 3.4 LOCAL SOURCE TSUNAMI SOPS

The meeting noted the importance of the SOP for local source tsunamis, especially in regard to building preparedness through natural warning signs, as well as taking into consideration a-typical tsunamis. There are two categories of SOPS: Tsunami Services Providers/ NTCs and CPA/ DMO and natural warnings. The local source tsunami SOP would also be a good reference for UNESCO-IOC Tsunami Ready. SOP development for a-typical tsunamis is ongoing.

The IOC Tsunami Glossary is being updated to include new information on volcanic and landslides sources.

### **Recommendations to TOWS-WG**

**Notes** the importance of the SOP for local source tsunamis, especially in regard to building preparedness through natural warning signs, as well as taking into consideration a-typical tsunamis;

**Notes** that the local source tsunami SOP would also be a good reference for UNESCO-IOC Tsunami Ready;

**Notes** the IOC Tsunami Glossary is being updated to include new information on volcanic and landslides sources;

**Recommends** that ICGs / Working Groups to further advance the discussion on local source tsunami SOPs.

### 3.5 NTWC COMPETENCY FRAMEWORK

OTGA plans to develop courses to support TEMP and Tsunami Ready. This will be further discussed in the agenda item on training.

### **Recommendations to TOWS-WG**

**Notes** the International Tsunami Information Centre (ITIC) report on the NTWC Competency Framework to the TT-TWO regarding progressing on finalizing the PTWS Framework, and piloting training according to the Framework in Tonga in 2019;

**Notes** that ITIC and the Indonesia BMKG have been designated as Ocean Teacher Global Academy Specialized Training Centres (OTGA STC) in 2020;

**Notes** the confirmation by ITIC that it will take the lead to develop such training under the OTGA, in collaboration with the IOC, TICs, practitioner experts, and Indonesia BMKG;

**Requests** the ITIC to report to the TT on the progress at the next TOWS meeting.

### 3.6 TSUNAMI EVACUATION MAPPING

The Tsunami Evacuation Maps, Plans, and Procedures training is also part of a Specialized Training Centres program under OTGA and will support Tsunami Ready. This was further discussed under the training agenda.

The JRC-Malta Last Mile project has completed tsunami evacuation mapping in Marsaxlokk town. The project outcome will be shared at the next TT DMP meeting.

### **Recommendations to TOWS-WG**

**Appreciates** the development of exercise guidance by the Caribbean through a draft IOC Manual Guide 86;

**Notes** that community exercise is a Tsunami Ready indicator;

**Encourages** the CARIBE-EWS to finalize, publish, and translate the IOC Manual Guide 86 in Spanish and French;

**Agrees** that the TOWS TT-DMP consider IOC Manual Guide 86 for global applicability.

### 3.7 STRUCTURAL DESIGN GUIDANCE

The Group was informed that ITIC has completed an evaluation on structural design guidance since June / July 2020. The document is available online at:

[http://itic.ioc-unesco.org/index.php?option=com\\_content&view=article&id=2070&Itemid=2927](http://itic.ioc-unesco.org/index.php?option=com_content&view=article&id=2070&Itemid=2927)

#### **Recommendations to TOWS-WG**

**Notes with appreciation** the completion by ITIC of the compilation of international structural design guidance for buildings used as evacuation shelters, and its sharing through the ITIC web site, per the request of the PTWS and TOWS TT-DMP;

**Recommends** Member States to use best practices in engineering design and construction of evacuation shelters, especially where local tsunami hazards exist.

### 3.8 SCHOOLS PROGRAMMES

IOTIC has posted the list of school disaster risk reduction and preparedness materials of Global Alliance for Disaster Risk Reduction and Resilience in the Education Sector (GADRRRES). The list includes approximately 107 references, provides information on existing risk reduction and resilience education materials that is accessible on various websites. The school disaster risk reduction and preparedness materials are based on the 3 pillars of the Comprehensive School Safety Framework. This list was set up in 2019 and is now being updated with new information and materials from 2020 (UNICEF is expected to perform this update).

These school disaster risk reduction and preparedness materials could be used as reference when working with schools under the tsunami ready community programme.

INGV, TSP is carrying out additional risk perception studies in new areas in Italy with the aim to also support school programmes. The Italian Department of Civil Protection has undertaken a national communication campaign “I don’t take risks – Tsunami” since 2013, with the objective of dissemination of risk knowledge and rules of behaviour to adopt before, during and after a tsunami event. The programme also targets schools.

The Chairperson concluded that the meeting considers this particular recommendation as achieved.

#### **Recommendations to TOWS-WG**

**Notes with appreciation** the completion by IOTIC of the compilation of school DRR and preparedness materials;

**Recommends** its inclusion as a resource by Member States, especially as part of Tsunami Ready pilots that include schools.

### 3.9 WTAD 2020 AND WTAD 2021

The United Nations Office for Disaster Risk Reduction (UNDRR) remarked that the World Tsunami Awareness Day (WTAD) 2020 activities were interesting and engaging despite the pandemic crisis. The two high level events, in particular the third Tsunami Museum Conference which showcased how museums contribute to keeping the memory of past disasters and lessons learned, through survivor’s testimonies were impactful.

UNDRR pointed out the WTAD 2021 theme will relate to Target F of the Sendai Framework for DRR which is to substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of the present Framework by 2030.

UNDRR highlighted the fact that the WTAD planning was progressively being initiated earlier every year. For 2021, they will be leveraging the 10th anniversary of Great Japan on 11 March 2021 through the release of a video message by the UN Secretary-General, António Guterres, and the UNDRR Special Representative. These features will emphasize the theme of International Cooperation.

The Group noted the growing support and partnership between IOC and UNDRR in connection with the WTAD.

Possible activities envisaged for WTAD 2021 include:

- Showcasing Portugal as the recent TSP,
- More visual materials produced,
- Promote international cooperation to developing countries/ SIDS. Support countries in identifying needs and achieve DRR actions,
- Engage in regional DRR platforms –include tsunami risk / TR in collaboration with UNDRR regional offices and Platform host countries,
- Promote and build partnerships depending on specific ideas/activities–WMO collaboration with the meteorological offices and the opportunity for collaboration with NWS NOAA Weather Ready Nations initiatives,
- Videos –NTWC/TSPs –Warning element showcased,
- Dialogue with development agencies. What can we learn? What makes international cooperation in developing countries successful? What are their perspectives?
- Link the WTAD with Ocean Decade-Safe Societal benefit outcome. Many materials are currently being prepared,
- Request countries for newsworthy activities to be highlighted,
- UNDRR requested the TTDMP to also consider initiatives, which can be promoted on the day itself.

#### **Recommendations to TOWS-WG**

**Appreciates** the UNDRR IOC World Tsunami Awareness (WTAD) 2020 campaign consisting of high-level events, regional webinars, social media visuals, videos, and eyewitness accounts;

**Appreciates** the creation of fifteen videos highlighting countries joining the global Tsunami Ready community;

**Notes** that the 2021 WTAD, November 5, will highlight Target F of the Sendai Framework on international cooperation to developing countries through support to the implementation of their national and local strategies for disaster risk reduction;

**Recommends** the continued strong collaboration between the IOC and UNDRR for the 2021 WTAD highlighting among other initiatives the UN Decade for Ocean Science for Sustainable Development and the Tsunami Program transformative goals for 100% Global Tsunami Ready for highly vulnerable communities and deployment of Science Monitoring and Reliable Telecommunications (SMART ) undersea cables for disaster warning.

### 3.10 MULTI-ANNUAL COMMUNITY TSUNAMI EXERCISE PROGRAMME

The CARIBE-EWS Draft *Multi-Annual Community Tsunami Exercise Programme* was reviewed and approved by WG 4 and the ICG for publishing as IOC Manuals and Guides, 86. It is still open for review. The meeting discussed whether it should be published as a CARIBE-EWS document or a Task Team document. This document is particularly focused on community level evacuation, and thus differs from the 2015 Indian Ocean exercise guidelines and the IOC exercise manual which both focus on evacuation guidelines and exercises at the national level.

The Group agreed to circulate the draft of the CARIBE-EWS Manuals and Guides, 86 on the TT DMP meeting website.

### 3.11 TSUNAMI GLOSSARY

ITIC reported on the receipt of a request from Portugal for the '1755 tsunami in Lisbon', Portugal to be renamed as the 'Northwest Iberian Margin event'.

#### **Recommendations to TOWS-WG**

**Notes** the report from the Director of ITIC about updates to the Glossary that have been identified or requested;

**Recommends** that the ITIC compiles proposed updates for vetting by the TT-TWO and TT-DMP and approval at the next TOWS meeting in 2022.

### 3.12 TSUNAMI GUIDANCE FOR MARITIME AND PORTS

ITIC reported to have finished the Marine Port Guideline and it is now available on the ITIC website. Concerning the materials available from Japan, a formal request for translation should be requested to have them translated to English.

#### **Recommendations to TOWS-WG**

**Appreciates** the completion by ITIC of the compilation of international guidance for maritime and ports, and its sharing through the ITIC web site: [http://itic.ioc-unesco.org/index.php?option=com\\_content&view=article&id=2071&Itemid=2926](http://itic.ioc-unesco.org/index.php?option=com_content&view=article&id=2071&Itemid=2926)), per request of the PTWS and TOWS TT-DMP;

**Notes** the pending TOWS WG request to Japan to assist in the translation of Japan's best practices; and

**Requests** IOC to identify possible funding sources to translate this document to English and other languages;

**Requests** the IOC to report on the progress at the next TOWS TT DMP;

**Agrees** that the TT DMP considers the development of guidelines at its next meeting.

### 3.13 INDONESIA ISO COMMUNITY BASED EARLY WARNING SYSTEMS

The meeting was informed that a vote was conducted by the Secretariat involving 48 countries. Twenty-three (23) countries approved Indonesia ISO Community Based Early Warning Systems, two approved with comments, whilst twenty-three (23) countries abstained. A meeting will be convened in June 2021 hosted by Germany.

## 4. TRAINING

ITIC and IOTIC presented the plan and progress of the training activities and programme under the Ocean Teacher Global Academy. ITIC and BMKG Indonesia have received the status of Specialized Training Centre for Tsunamis. Under the coordination of the Tsunami Unit in UNESCO-IOC and in collaboration with the Tsunami Information Centres (CTIC, ITIC, IOTIC, NEAMTIC), the STCs will work on developing 7 planned courses until 2023. The training programmes consist of Tsunami Awareness, Tsunami Ready, Tsunami Early Warning Systems, Tsunami Warning and Emergency Response SOPs, TEMPP, and Tsunami Warning Centre Competencies. These training courses will be developed based on the related IOC Manual Guides and training that have been implemented by the TICs. Some courses have been developed with hybrid delivery in mind.

More information on the IOC's IODE OTGA Project can be found at: <https://classroom.oceanteacher.org> and through the OTGA brochure and a presentation can be found on the TT-DMP meeting site: [http://www.ioc-tsunami.org/index.php?option=com\\_oe&task=viewEventDocs&eventID=2894](http://www.ioc-tsunami.org/index.php?option=com_oe&task=viewEventDocs&eventID=2894).

The Group noted that adequate resources are critical to training sustainability. Funding has been earmarked from the UNESCO/IOC Regular Budget to support maintenance. OTGA is also funding specific components e.g., consultants to put in a Moodle format and IT support to host the platform. The Meteorology, Climatology and Geophysical Agency (BMKG) is providing contributions as part of the UNESCO/IOC agreement arrangement and some resources from INDOCAP.

As NOAA continues to support Tsunami Ready in CARIBE and North Pacific, there are opportunities for supporting in-country activities and other upscaling activities, and to further develop online modules e.g. on DEMs and Inundation Modelling. A complete presentation is part of the meeting document.

### Recommendations to TOWS-WG

**Notes** that the ITIC and the Indian Ocean Tsunami Information Centre (IOTIC) presented the plan and progress of the training activities and programme under the Ocean Teacher Global Academy (OTGA), and that ITIC and the Meteorology, Climatology, and Geophysical Agency, Indonesia) (BMKG) have received the status of Specialized Training Centre (STC) for Tsunamis;

**Notes** that under the coordination of the Tsunami Unit in UNESCO-IOC and in collaboration with the Tsunami Information Centres (CTIC, ITIC, IOTIC, NEAMTIC) seven planned courses will be developed until 2023;

**Notes** that the training programmes consist of Tsunami Awareness, Tsunami Ready, Tsunami Early Warning Systems, Tsunami Warning and Emergency Response SOPs (Standard Operating Procedures), TEMPP (Tsunami Evacuation Maps, Plans, and Procedures), and Tsunami Warning Centre Competencies. These training courses will be developed based on the related IOC Manual Guides and training that have been implemented by the TICs. Some courses have been developed with hybrid delivery in mind;

**Notes** the ITIC and Indonesia BMKG as OTGA STC will report on the progress at the next TOWS TT-DMP.

## 5. TSUNAMI READY PILOT PROGRAMME

The Task Team noted the significant progress achieved by NEAMTIC/ICG/NEAMTWS, CTIC, IOTIC in piloting Tsunami Ready in each basin. There is a strong link observed between Tsunami Ready and WTAD efforts.

### 5.1 NEAM REGION

Ms Cecelia Valbonesi reported on the development of Tsunami Ready in the NEAM region. Countries involved in exploring the Tsunami Ready initiative are France, Italy, Portugal, Greece, and Spain (although there is only documentation for France and Italy). The city of Cannes, France, is developing a Tsunami Ready programme in collaboration with a national working group. They have notably established evacuation routes and plans, tsunami signs, signed a tsunami charter in 2019, and are developing tsunami early warning for the population in collaboration with the civil defense. In addition, they are conducting tsunami tests, as well as surveys with the local population and tourists to assess tsunami knowledge. In Italy (Minturo), a Tsunami Ready programme is also being pursued. Several steps have been taken, including testing warning systems, designating, and mapping hazard zones, and estimating the amount of people in risk zones. They have achieved several Tsunami Ready indicators, such as number 4, 5, 6, and 12.

In the NEAM region, the administrative challenges related to the national administrative procedures were noted. An IOC Circular Letter was also sent out to encourage countries to initiate Tsunami Ready programme and nominate experts to contribute to TR under Working Group 4 (Education, Awareness and Preparedness).

### 5.2 CARIBE REGION

Ms Alison Brome reported on the status and progress of the implementation of Tsunami Ready in the CARIBE region. There are currently a total of 14 Tsunami Ready communities in 11 Member States of the CARIBE region, with 4 communities covered by the DIPECHO project which ended in 2020. Some Tsunami Ready areas are territory wide, whilst others are at the level of local communities. There are currently 5 TR communities in progress with NOAA providing support to 3 of these. Additional projects are being conceptualized by NOAA. In addition, 3 communities are in the process of renewals, but these have been slowed down due to the COVID-19 pandemic.

The CARIBE region has also faced several constraints and challenges which have delayed activities. These obstacles include the: multi-hazard impact of COVID-19; the hurricane season; political transitions in the region; a dengue outbreak, as well as volcanic activity. As a result, access to data, technological support, and expertise were limited. Competing priorities of national authorities and limited funding also provided some constraints. These challenges impeded Tsunami Ready roll out and strategies in the Caribbean.

### 5.3 INDIAN OCEAN REGION

Mr Ardito Kodijat reported on Tsunami Ready in the Indian Ocean region. Within the IOTWMS, the IOTIC have been working on Tsunami Ready at the regional level, while the Member States will undertake the implementation at national level. IOTIC does not have any project to support the implementation of Tsunami Ready at the national level as the other TICs. In the past years IOTIC have supported Member States through providing guidelines, advocacy, and training. At the end of 2019, IOTWMS (IOTIC and ICG/IOTWMS secretariat) conducted a review of two

communities in Odisha, India on fulfilling the UNESCO-IOC Tsunami Ready indicators. These two communities, Noliasahi and Venkatraipur received UNESCO-IOC Tsunami Ready recognition in July 2020. The State of Odisha Disaster Management Agency is committed to implement Tsunami Ready in 328 other villages in Odisha coastline in the next few years. BMKG of Indonesia has committed to implement Tsunami Ready in 5 villages in Indonesia in the next 2 years.

Due to COVID-19, IOTIC organized an online Lecture Series on Tsunami Ready reaching out to more than 2,100 participants. The 6 Lectures introduced the UNESCO-IOC Tsunami Ready Indicators and guide on how to pilot the Tsunami Ready in the community. On the occasion of the World Tsunami Awareness Day, the IOTIC organized a Webinar on Tsunami Ready for Indian Ocean Island States. Output of the webinar is a recommendation for IOTIC to develop a draft proposal to support the implementation of Tsunami Ready in Indian Ocean Island States.

IOTIC will continue to advocate, promote, and support the implementation of Tsunami Ready in Indian Ocean aligned with the societal outcome of the Safe Ocean of the UN Ocean Decade. The IOTIC will support the development of the OTGA Tsunami Ready training module jointly with BMKG and the other Tsunami Information Centres.

#### 5.4 PACIFIC REGION

Ms Laura Kong reported on the development of Tsunami Ready in the Pacific region. There are currently 4 countries that are recognized as Tsunami Ready (El Salvador, Honduras, Costa Rica and Samoa) with a total of 8 communities. There are several Tsunami Ready activities in progress in Central America (Costa Rica, Guatemala, and Panama), South America (Ecuador and Chile), Pacific islands (Fiji, Solomons, Vanuatu, and Cook Islands), and Southeast Asia (Viet Nam). There are also planned Tsunami Ready activities in the Pacific islands (Marshall Islands, Fiji, Micronesia, and Palau) through US funds.

The ITIC is hosting the UNESCO-IOC Tsunami Ready web site ([www.tsunamiready.org](http://www.tsunamiready.org), or [http://itic.ioc-unesco.org/index.php?option=com\\_content&view=category&id=2234&Itemid=2758](http://itic.ioc-unesco.org/index.php?option=com_content&view=category&id=2234&Itemid=2758)). A page will be created for each community that is designated as Tsunami Ready. Each page provides a standard set of information, including from the recognition process (certificates and the application), any related media releases, evacuation maps, and awareness materials.

ITIC proposed to add definitions for the next update of Tsunami Glossary (expected in 2022) as follows:

##### Tsunami Ready

Set of community-level indicators that elaborate a global standard of key actions to minimize the loss of life, livelihoods and property from tsunamis. The indicators cover hazard evaluation, mitigation, preparedness, and response. Being Tsunami Ready does not mean that a community is tsunami proof, but rather it is an acknowledgment and recognition of the measures adopted by the community to cope with their tsunami threat.

##### Tsunami Ready Programme (UNESCO-IOC)

Modelled after the US TsunamiReady® Program, the UNESCO-IOC Tsunami Ready programme is a voluntary, performance-based program to recognize communities that have fulfilled the established Tsunami Ready indicators. This programme promotes an understanding of the concept of readiness as an active collaboration among national and local warning and emergency management agencies and government authorities, scientists,



community leaders, residents and non government stakeholders. The Programme was established in the Caribbean in 2015 and expanded globally in 2017.

#### Tsunami Ready Community (UNESCO-IOC)

A community that has met the Tsunami Ready indicators and been recognized by the UNESCO-IOC as Tsunami Ready. Tsunami Ready communities are aware of the risks they face from tsunamis and have taken steps to address them.

#### **Recommendations to TOWS-WG**

**Appreciates** the growing interest and excellent progress by Member States in all ICGs in piloting UNESCO IOC Tsunami Ready;

**Notes** the challenges of upscaling required to achieve 100% Tsunami Ready in highly vulnerable communities as one of the transformative goals of the UN Decade for Ocean Science for Sustainable Development Tsunami Programme;

**Notes** the progress by Indonesia in their application for ISO (International Organization for Standardization) certification of a Community Based Early Warning System;

**Appreciates** the continued support from the United States Agency for International Development / Bureau of Humanitarian Assistance) (USAID/BHA) and the European Commission Humanitarian Aid Department's Disaster Preparedness Programme (DIPECHO) and Member States to provide funding support to Tsunami Ready pilots and invites contributions from other agencies;

**Recommends** the urgent completion of the Tsunami Ready Guidelines (IOC Manual and Guides no 74) for widespread distribution to Member States; and

**Recommends** the IOC to finalize and provide guidance for a Tsunami Ready logo.

## **6. UN OCEAN DECADE**

Ms Christa von Hillebrandt-Andrade (ITIC/CTWP–CARIBE/EWS), acknowledged the significant advancements in the implementation of Tsunami Ready with pilots in all regions. She noted that the proposed goal of 100% of highly vulnerable communities being Tsunami Ready by 2030 is an audacious and transformative goal in line with the vision of the UN Decade of Ocean Science for Sustainable Development. It will require a step change in the implementation of the program. It is not business as usual, but rather bold and transformative. An ambitious aim is to have 2000 communities recognized as Tsunami Ready communities by 2030, considering that 325 villages are committed to Tsunami Ready in India alone.

Some of the challenges that will need to be addressed include: defining the number of target tsunami ready communities, human resources for administration and facilitation, acquiring data related to coastal bathymetry and topography and tsunami sources for inundation modeling and mapping, implementation at regional, national local levels, guidelines and tools/training for each of the indicators, inclusion of countries that have their own 'tsunami ready' programmes and the need for local/national TR champions and funding.

Opportunities to accelerate the implementation of the program include virtual/blended training like OTGA, regional modeling and training hubs with a special focus on universities and optimization of the regional and national exercises for community exercises.

Other opportunities noted were the synergies with the Sendai Framework (local and national disaster risk reduction strategies) and the WMO efforts in Multi Hazard Warning Systems. It is critical to establish alliances with other stakeholders such as WMO, and those working in community-based disaster risk reduction like Red Crescent and Red Cross. This also includes collaborating with NGOs, establishing community champions, creating regional and national bathymetry grids, and online/blended training.

Given the need for a strategy for implementation, it was recommended that a Tsunami Ready Coalition with a broad group of stakeholders be established.

### **Recommendations to TOWS-WG**

**Considers** the high number of population living along the coastlines that are at risk of tsunamis, the strong interest from Member States across all ICGs in implementing Tsunami Ready, and the opportunity for transformational and bold actions as part of the UN Decade of Ocean Science for Sustainable Development (2021-2030);

**Recommends** that the TOWS-WG proposes a Comprehensive Tsunami Programme under the UN Decade dedicated to achieving the societal outcome of “A Safe Ocean” with the aim of making 100% of highly vulnerable communities prepared for and resilient to tsunamis by 2030 through the implementation of the UNESCO/IOC Tsunami Ready Programme and other initiatives.

The TT DMP **further recommends** that this Comprehensive Decade Tsunami Programme should focus on inclusiveness and delivery through:

1. The adoption and continued implementation of the UNESCO/IOC Tsunami Ready Guidelines and Indicators as the international standard for evidence-based community preparedness for tsunamis,
2. Enhanced access and capacity development for high-resolution near shore bathymetry and topography data and tsunami source identification for accurate and improved inundation modelling and evacuation mapping and planning in support of Tsunami Ready communities,
3. Enhanced integration to minimize tsunami disaster impacts and to enable rapid restoration of socio-economic activities and critical infrastructure services post tsunami impacts.

The establishment of a Tsunami Ready Coalition of stakeholders charged with delivering a strategic plan for consideration at TOWS-WG-XV to facilitate the implementation of the Comprehensive Decade Tsunami Programme through the UNESCO/IOC Tsunami Ready Programme and other initiatives.

### **Recommendations to TOWS-WG**

**Continuation** of the TT DMP for the next intercessional period.

## **7. CLOSING**

The Chairperson Mr David Coetzee closed the TT DMP agenda items. Mr Denis Chang Seng, IOC Technical Secretary, thanked the Chairperson for his leadership, and he remarked that the virtual meeting was very efficient and productive. He thanked everyone for their participation and support.

The TOWS-WG-XIV TT DMP meeting was closed at 12:00 hrs, 23 February 2021.

## **8. SUMMARY OF RECOMMENDATIONS TO THE TOWS-WG-XIV**

**Notes** that due to the COVID-19 pandemic the WAVE exercises workshop has not yet convened, and that Caribe Wave 20, PacWave20, IOWave20 exercises did take place in 2020, and planning for future exercise is pending or underway;

**Requests** the Secretariat to organize a virtual meeting on WAVE exercises to improve coordination, so as to minimize timing conflicts, share best practices for exercise evaluation and the use of online tools; and

**Agrees** to share outcomes, lessons learned of regional exercises with relevant ICG Working Groups;

**Notes** that the PTWS is the only ICG with International Cooperation indicators and the theme of the World Tsunami Awareness Day 2021 will link with the target F of the Sendai Framework for DRR (2015-2030) on International cooperation to developing countries;

**Recommends** that the CARIBE-EWS, IOTWMS, and NEAMTWS to strongly consider including International Cooperations in their Key Performance Indicators (KPIs) ;

**Recommends** that the Task Team on KPIs complete the work on harmonized performance monitoring framework including data collection tools/questionnaire and reporting formats for presentation to the next TOWS meeting;

**Requests** the Secretariat to arrange a virtual meeting of the Task Team on KPIs in the near future to discuss a work plan;

**Notes** the importance of the SOP for local source tsunamis, especially in regard to building preparedness through natural warning signs, as well as taking into consideration atypical tsunamis;

**Notes** that the local source tsunami SOP would also be a good reference for UNESCO-IOC Tsunami Ready;

**Notes** the IOC Tsunami Glossary is being updated to include new information on volcanic and landslides sources;

**Recommends** that ICGs / Working Groups to further advance the discussion on local source tsunami SOPs;

**Notes** the International Tsunami Information Centre (ITIC) report on the NTWC Competency Framework to the TT-TWO regarding progressing on finalizing the PTWS Framework, and piloting training according to the Framework in Tonga in 2019;

**Notes** that the ITIC and the Indian Ocean Tsunami Information Centre (IOTIC) presented the plan and progress of the training activities and programme under the Ocean Teacher Global Academy (OTGA), and that ITIC and the Meteorology, Climatology, and Geophysical Agency, Indonesia) (BMKG) have received the status of Specialized Training Centre (STC) for Tsunamis in 2020;

**Notes** that under the coordination of the Tsunami Unit in UNESCO IOC and in collaboration with the Tsunami Information Centres (CTIC, ITIC, IOTIC, NEAMTIC) seven planned courses will be developed until 2023;

**Notes** that the training programmes consist of Tsunami Awareness, Tsunami Ready, Tsunami Early Warning Systems, Tsunami Warning and Emergency Response SOPs (Standard Operating Procedures), TEMPP (Tsunami Evacuation Maps, Plans, and Procedures), and Tsunami Warning Centre Competencies. These training courses will be developed based on the related IOC Manual Guides and training that have been implemented by the TICs. Some courses have been developed with hybrid delivery in mind;

**Notes** the confirmation by ITIC that it will take the lead to develop such training under the OTGA, in collaboration with the IOC, TICs, practitioner experts, and Indonesia BMKG;

**Notes** the ITIC and Indonesia BMKG as OTGA STC will report on the progress at the next TOWS TT DMP;

**Appreciates** the development of exercise guidance by the Caribbean through a draft IOC Manuals and Guides 86;

**Notes** that community exercise is a Tsunami Ready indicator;

**Encourages** the CARIBE-EWS to finalize, publish, and translate the IOC Manuals and Guides 86 in Spanish and French;

**Agrees** that the TOWS TT-DMP consider IOC Manual Guide 86 for global applicability;

**Notes with appreciation** the completion by ITIC of the compilation of international structural design guidance for buildings used as evacuation shelters, and its sharing through the ITIC web site, per the request of the PTWS and TOWS TT-DMP;

**Recommends** Member States to use best practices in engineering design and construction of evacuation shelters, especially where local tsunami hazards exist;

**Notes with appreciation** the completion by IOTIC of the compilation of school DRR and preparedness materials;

**Recommends** its inclusion as a resource by Member States, especially as part of Tsunami Ready pilots that include school;

**Appreciates** the UNDRR IOC World Tsunami Awareness (WTAD) 2020 campaign consisting of high-level events, regional webinars, social media visuals, videos, and eyewitness accounts;

**Appreciates** the creation of fifteen videos highlighting countries joining the global Tsunami Ready community;

**Notes** that the 2021 WTAD, November 5, will highlight Target F of the Sendai Framework on international cooperation to developing countries through support to the implementation of their national and local strategies for disaster risk reduction;

**Recommends** the continued strong collaboration between the IOC and UNDRR for the 2021 WTAD highlighting among other initiatives the UN Decade for Ocean Science for Sustainable Development and the Tsunami Program transformative goals for 100% Global Tsunami Ready for highly vulnerable communities and deployment of Science Monitoring and Reliable Telecommunications (SMART ) undersea cables for disaster warning;

**Notes** the report from the Director of ITIC about updates to the Glossary that have been identified or requested;

**Recommends** that the ITIC compiles proposed updates for vetting by the TT-TWO and TT-DMP and approval at the next TOWS meeting in 2022;

**Appreciates** the completion by ITIC of the compilation of international guidance for maritime and ports, and its sharing through the ITIC web site: [http://itic.ioc-unesco.org/index.php?option=com\\_content&view=article&id=2071&Itemid=2926](http://itic.ioc-unesco.org/index.php?option=com_content&view=article&id=2071&Itemid=2926)), per request of the PTWS and TOWS TT-DMP;

**Notes** the pending TOWS WG request to Japan to assist in the translation of Japan's best practices; and

**Requests** IOC to identify possible funding sources to translate this document to English and other languages;

**Requests** the IOC to report on the progress at the next TOWS TT DMP;

**Agrees** that the TT DMP considers the development of guidelines at its next meeting;

**Appreciates** the growing interest and excellent progress by Member States in all ICGs in piloting UNESCO/IOC Tsunami Ready;

**Notes** the challenges of upscaling required to achieve 100% Tsunami Ready in highly vulnerable communities as one of the transformative goals of the UN Decade for Ocean Science for Sustainable Development Tsunami Programme;

**Notes** the progress by Indonesia in their application for ISO (International Organization for Standardization) certification of a Community Based Early Warning System;

**Appreciates** the continued support from the United States Agency for International Development / Bureau of Humanitarian Assistance) (USAID/BHA) and the European Commission Humanitarian Aid Department's Disaster Preparedness Programme (DIPECHO) and Member States to provide funding support to Tsunami Ready pilots and invites contributions from other agencies;

**Recommends** the urgent completion of the Tsunami Ready Guidelines (IOC Manuals and Guides, 74) for widespread distribution to Member States; and

**Recommends** the IOC to finalize and provide guidance for the Tsunami Ready logo;

**Considers** the high number of population living along the coastlines that are at risk of tsunamis, the strong interest from Member States across all ICGs in implementing Tsunami Ready, and the opportunity for transformational and bold actions as part of the UN Decade of Ocean Science for Sustainable Development (2021–2030);

**Recommends** that the TOWS WG proposes a Comprehensive Tsunami Programme under the UN Decade dedicated to achieving the societal outcome of A Safe Ocean with the aim of making 100% of highly vulnerable communities prepared for and resilient to tsunamis by 2030 through the implementation of the UNESCO/IOC Tsunami Ready Programme and other initiatives;

The TTDMP **further recommends** that this Comprehensive Decade Tsunami Programme should focus on inclusiveness and delivery through:

1. The adoption and continued implementation of the UNESCO/IOC Tsunami Ready Guidelines and Indicators as the international standard for evidence-based community preparedness for tsunamis,

2. Enhanced access and capacity development for high-resolution near shore bathymetry and topography data and tsunami source identification for accurate and improved inundation modelling and evacuation mapping and planning in support of Tsunami Ready communities,
3. Enhanced integration to minimize tsunami disaster impacts and to enable rapid restoration of socio-economic activities and critical infrastructure services post tsunami impacts,

The establishment of a Tsunami Ready Coalition of stakeholders charged with delivering a strategic plan for consideration at TOWS-WG-XV to facilitate the implementation of the Comprehensive Decade Tsunami Programme through the UNESCO/IOC Tsunami Ready Programme and other initiatives;

The **Continuation** of the TT DMP for the next intersessional period.

ANNEX V

LIST OF PARTICIPANTS

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ANNEX VI

**LIST OF ACRONYMS**

<b>BMKG</b>	Indonesian Agency for Meteorological, Climatological and Geophysics
<b>CARIBE-EWS</b>	Tsunami and Other Coastal Hazards Warning System for the Caribbean and Adjacent Regions
<b>CARIBE WAVE</b>	Caribbean Wave Exercise
<b>CATAC</b>	Central America Tsunami Advisory Center
<b>CATSAM</b>	Caribbean and Adjacent Regions Tsunami Sources and Models
<b>CEPREDENAC</b>	Coordination Center for the Prevention of Natural Disasters in Central America
<b>CENALT</b>	Centre National d'Alerte aux Tsunamis (France)
<b>CIFI</b>	Inundation Forecasting Initiative
<b>CMA2</b>	Caribbean Marine Atlas
<b>DART</b>	Deep-ocean Assessment and Reporting of Tsunamis
<b>DG-ECHO</b>	Directorate-General for European Civil Protection and Humanitarian Aid Operations
<b>DRR</b>	Disaster Risk Reduction
<b>ERCC</b>	European Emergency Response Coordination Centre
<b>EWS</b>	Tsunami Early Warning System
<b>FDSN</b>	International Federation of Digital Seismograph Networks
<b>GMAS</b>	Global Multi-hazard Alert System (WMO)
<b>GNSS</b>	Global Navigation Satellite System
<b>GSDD</b>	Global Service Definition Document
<b>GTS</b>	Global Telecommunication System (WMO)
<b>ICG</b>	Intergovernmental Coordination Group

<b>ICG/CARIBE-EWS</b>	Intergovernmental Coordination Group for the Tsunami and Other Coastal Hazards Warning System for the Caribbean and Adjacent Regions
<b>ICG/IOTWMS</b>	Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System
<b>ICG/NEAMTWS</b>	Intergovernmental Coordination Group for the Tsunami Early Warning and Mitigation System in the North-eastern Atlantic, the Mediterranean and Connected Seas
<b>ICG/PTWS</b>	Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System
<b>IHO</b>	International Hydrographic Organization
<b>IMO</b>	International Maritime Organization
<b>INFCOM</b>	Infrastructure Commission (WMO)
<b>INGV</b>	Istituto Nazionale di Geofisica e Vulcanologia (Italy)
<b>IOC</b>	Intergovernmental Oceanographic Commission
<b>IOTIC</b>	Indian Ocean Tsunami Information Centre
<b>IOTWMS</b>	Indian Ocean Tsunami Warning and Mitigation System
<b>IOWave</b>	Indian Ocean Wave Exercise
<b>IPMA</b>	Instituto Português do Mar e da Atmosfera (Portugal)
<b>ISO</b>	International Organization for Standardization
<b>ITIC</b>	International Tsunami Information Center
<b>ITST</b>	International Tsunami Survey Team
<b>ITU</b>	International Telecommunication Union
<b>JCB</b>	Joint Collaborative Board (of WMO-IOC)
<b>JCOMM</b>	Joint Technical Commission for Oceanography and Marine Meteorology
<b>JTF</b>	Joint Task Force
<b>KOERI</b>	Kandilli Observatory and Earthquake Research (Turkey)
<b>KPI</b>	Key Performance Indicator

<b>LDCs</b>	Least Developed Countries
<b>MHEWS</b>	Multi-Hazard Early Warning Systems
<b>MoU</b>	Memorandum of Understanding
<b>NEAM</b>	North-eastern Atlantic, the Mediterranean and Connected Seas
<b>NEAM Wave</b>	North-eastern Atlantic, the Mediterranean and Connected Seas Wave Exercise
<b>NEAMTIC</b>	Tsunami Information Centre for the North-eastern Atlantic, the Mediterranean and Connected Seas
<b>NEAMTWS</b>	Tsunami Early Warning and Mitigation System in the North-eastern Atlantic, the Mediterranean and Connected Seas
<b>NOA</b>	National Observatory of Athens (Greece)
<b>NOAA</b>	National Oceanic and Atmospheric Administration
<b>NTWC</b>	National Tsunami Warning Center
<b>NWPTAC</b>	North West Pacific Tsunami Advisory Center
<b>ORSNET</b>	Oceania Regional Seismic Network
<b>OTGA</b>	Ocean Teacher Global Academy
<b>OTGA STC</b>	Ocean Teacher Global Academy Specialized Training Centres
<b>PacWave</b>	Pacific Wave Exercise
<b>PI</b>	Performance Indicator
<b>PTWC</b>	Pacific Tsunami Warning Centre
<b>PTWS</b>	Pacific Tsunami Warning and Mitigation System
<b>SC</b>	Steering Committee
<b>SC-DRR</b>	Standing Committee for Disaster Risk Reduction (WMO)
<b>SC-MMO</b>	Standing Committee for Marine Meteorology and Oceanographic Services (WMO)
<b>SCSTAC</b>	South China Sea Tsunami Advisory Centre
<b>SEED</b>	Standard for Exchange of Earthquake Data

<b>SEP</b>	South East Pacific Region
<b>SICA</b>	Central America System of Integration
<b>SIDS</b>	Small Island developing States
<b>SMART</b>	Science Monitoring And Reliable Telecommunications
<b>SOP</b>	Standard Operating Procedure
<b>TEMPP</b>	Tsunami Evacuation Maps, Plans and Procedures
<b>TIC</b>	Tsunami Information Centres
<b>TOWS-WG</b>	Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems
<b>TSP</b>	Tsunami Service Provider
<b>TSU</b>	Tsunami Unit
<b>TSUCAT</b>	Tsunami Coastal Assessment Tool
<b>TT</b>	Task Team
<b>TTDMP</b>	Task Team on Disaster Management and Preparedness
<b>TTTWO</b>	Task Team on Tsunami Watch Operations
<b>TWFP</b>	Tsunami Warning Focal Point
<b>UN</b>	United Nations
<b>UNAVCO</b>	NAVCO, Inc. (independent, non-profit,corporation)
<b>UNDRR</b>	United Nations Office for Disaster Risk Reduction
<b>UNESCAP</b>	UN Economic and Social Commission for Asia and the Pacific
<b>UNESCO</b>	United Nations Educational, Scientific and Cultural Organization
<b>UNGA</b>	United nations General Assembly
<b>WG</b>	Working Group
<b>WIS</b>	WMO Information System
<b>WMO</b>	World Meteorological Organization
<b>WTAD</b>	World Tsunami Awareness Day

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 Intercalibration
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 Internacional 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 Intercalibration
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 Intercalibration
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<sub>2</sub> 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 CO<sub>2</sub> 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
119. 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<sub>2</sub> 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<sub>2</sub> 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, China, 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-GTSP), 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**)