

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)**

Thirteenth Meeting
Paris, France
20–21 February 2020

UNESCO

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Executive Summary

The Thirteenth Meeting of the Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG-XIII) was held at UNESCO Headquarters in Paris, on 20–21 February 2020 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 Thirtieth session (26 June–4 July 2019, Paris).

The Group recognized there remains a fundamental capability gap when it comes to providing accurate, actionable tsunami forecasts to the most at-risk coastal communities. The Group has fully described this gap through a combination of peer-reviewed publications, conferences and consultations over the past two years.

The Group further recognized that the UN Decade of Ocean Science for Sustainable Development provides a once-in-a-generation opportunity to address and potentially fill this gap by leveraging novel sensing platforms, techniques and/or infrastructures in order to quickly detect and measure tsunamis the near-instant they form.

The Group requested that the IOC Executive Council at its session in 2020 strongly advocate for the inclusion of a flagship initiative under the UN Decade of Ocean Science aimed at addressing this glaring capability gap in global tsunami forecast and warning services.

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

- Two exercises carried out (CARIBE WAVE 2019 and PACWAVE 2019) and regular communication tests performed,
- Ongoing progress in sharing the results of Tsunami exercises and communication tests with World Meteorological Organization (WMO) and improvements in alert message delivery rates for IOTWMS,
- Several communities having achieved Tsunami Ready recognition including Omoa and Tornabe (both Honduras), Bluefields and Corn Island (both Nicaragua), and more than ten communities in process of seeking Tsunami Ready recognition,
- Instituto Português do Mar e da Atmosfera (IPMA) having been accredited as a Tsunami Service Provider in NEAMTWS,
- South China Sea Tsunami Advisory Center (SCSTAC) (hosted at National Marine Environmental Forecasting Center of P. R. China (SCSTAC/NMEFC)) having started full operation on 5 November 2019,
- Central American Tsunami Advisory Center (CATAC) (hosted at Nicaraguan Institute of Territorial Studies (INETER)) started trial operation in August 2019,
- the International Symposium on lessons learnt from the 2018 Tsunamis in Palu and Sunda Strait, Jakarta, Indonesia, 26–28 September 2019 (see [summary statement](#)),
- efforts by Indonesia to densify its national detection network in response to the Palu and Sunda Strait events,
- efforts to strengthen tsunami resilience in Makran area through UNESCAP funded project “Strengthening tsunami early warning in the North West Indian Ocean region through regional cooperation”.

The Group approved changes to the Area of Service Map (Appendix 4 to Annex IV).

The Group recommended to the Executive Council at its session in 2020 to encourage Member States to:

- increase and sustain technical and financial support of the tsunami and other coastal hazards warning systems in their respective regions,
- emphasize to their national civil protection/disaster management agencies the role they play in strengthening the warning chain to ensure optimal community response; and stress the importance of the participation of their agencies in regional tsunami governance and technical forums,
- continue to strengthen tsunami awareness and preparedness in communities and among authorities through communication, evacuation planning, tsunami exercises, training, information, and piloting recognition programmes such as Tsunami Ready,
- densify sea level networks capable of Tsunami detection as well as seismic network particularly nearby tsunamigenic sources,
- implement a sample rate of 1 sample/sec or higher on sea level gauges in order to record and transmit tsunami wave-form data from all seismic and non-seismic sources,
- recommend that Member State authorities and station operators share existing seismic, sea level, GNSS and other data types, including their meta-data, in real or near real-time with Tsunami Service Providers and National Tsunami Warning Centres for a more effective and comprehensive global tsunami early warning,
- 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 commissions,
- 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,
- request their National Tsunami Warning Centres to make public national tsunami warnings available in the Common Alerting Protocol (CAP) format as an addition to their current messages, as applicable. This would allow this warning information together with other coastal hazard warnings to be widely disseminated and available on multiple platforms such as the Global Meteo Alert System (GMAS) under development by World Meteorological Organization.

The Group recommended the Executive Council at its session in 2020 to instruct the regional Intergovernmental Coordinating Groups to:

- advocate World Tsunami Awareness Day (WTAD) 2020 among their Member States and highlight target [e] of the Sendai Framework to *Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020*;
- continue the Tsunami Ready pilot activities with UNESCO-IOC recognition, including conducting surveys on Member State status, interest and feedback in the implementation of Tsunami Ready;

- enhance participation of Civil Protection Agencies in their routine activities;
- discuss procedures and best practices for local source tsunami response based on the guidelines provided by the Pacific Tsunami Warning System and as revised by the Indian Ocean Tsunami Warning and Mitigation System (*Document in progress: [Local-Source Tsunami Response Best Practice](#), version 1*).

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 operation.

The Group recommended the Executive Council at its session in 2020 to 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].

The Group expressed appreciation to Japan Meteorological Agency and the Northwest Pacific Tsunami Advisory Center (NWPTAC) for having provided interim service for the South China Sea from 2006 until the start of full operation of SCSTAC on 5 November 2019.

The Group noted with appreciation the information presented by WMO on its organizational changes and the newly established WMO-IOC Joint Collaborative Board.

Résumé exécutif

La 13^e 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-XIII) s'est tenue les 20 et 21 février 2020 au Siège de l'UNESCO, à Paris, 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^e session (26 juin – 4 juillet 2019, Paris).

Le Groupe a reconnu qu'il subsistait un manque fondamental de capacités s'agissant de fournir aux communautés côtières les plus exposées des prévisions précises et exploitables en matière de tsunamis. Il a décrit ces lacunes de façon exhaustive à travers un ensemble de publications évaluées par des pairs, de conférences et de consultations au cours des deux dernières années.

Le Groupe a également reconnu que la Décennie des Nations Unies pour les sciences océaniques au service du développement durable offrait une occasion unique de combler ces lacunes en tirant parti de plates-formes, de techniques et/ou d'infrastructures de détection novatrices afin de détecter et de mesurer rapidement les tsunamis, dès l'instant où ils se forment.

Le Groupe a demandé que le Conseil exécutif de la COI, à sa session de 2020, plaide vigoureusement en faveur du lancement d'une initiative phare, dans le cadre de la Décennie des Nations Unies pour les sciences océaniques au service du développement durable, visant à combler ce manque flagrant de capacités en matière de services mondiaux de prévision et d'alerte aux tsunamis.

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

- les deux exercices menés à bien (CARIBEWave 2019 et PACWave 2019) et les tests de communication régulièrement effectués ;
- les progrès continus dans la transmission des résultats des exercices d'alerte aux tsunamis et des tests de communication à l'Organisation météorologique mondiale (OMM) et l'amélioration du taux de diffusion des messages d'alerte du Système d'alerte aux tsunamis et de mitigation dans l'océan Indien (IOTWMS) ;
- la reconnaissance de plusieurs communautés dans le cadre du programme « Tsunami Ready », notamment Omoa et Tornabe (Honduras) et Bluefields et Corn Island (Nicaragua), ainsi que les processus en cours en vue de la reconnaissance de plus d'une dizaine d'autres communautés ;
- l'accréditation de l'Instituto Português do Mar e da Atmosfera (IPMA) en tant que prestataire de services relatifs aux tsunamis (TSP) dans le cadre du NEAMTWS ;
- le début des opérations du Centre consultatif sur les tsunamis en mer de Chine méridionale (SCSTAC), au sein du Centre national des prévisions relatives au milieu marin en Chine (SCSTAC/NMEFC), devenu pleinement opérationnel le 5 novembre 2019 ;
- le début des opérations, à titre expérimental, du Centre consultatif sur les tsunamis en Amérique centrale (CATAC), au sein de l'Instituto Nicaragüense de Estudios Territoriales (INETER), en août 2019 ;

- le colloque international sur les enseignements tirés des tsunamis survenus en 2018 à Palu et dans le détroit de la Sonde, organisé à Jakarta (Indonésie) du 26 au 28 septembre 2019 (voir le [compte rendu](#)) ;
- les efforts déployés par l'Indonésie pour étoffer son réseau national de détection après les tsunamis survenus à Palu et dans le détroit de la Sonde ;
- les efforts déployés pour accroître la résilience face aux tsunamis dans la zone de subduction du Makran grâce au projet « Renforcement des alertes rapides aux tsunamis dans la région de l'océan Indien du Nord-Ouest par la coopération régionale » financé par la Commission économique et sociale pour l'Asie et le Pacifique (CESAP) ;

Le Groupe a approuvé les modifications apportées à la carte de la zone de couverture (voir l'appendice 4 de l'annexe IV).

Le Groupe a recommandé au Conseil exécutif de la COI, à sa session de 2020, d'encourager les États membres à :

- accroître et pérenniser leur appui technique et financier aux systèmes d'alerte aux tsunamis et autres aléas côtiers dans leurs régions respectives ;
- mettre en avant le rôle joué par les organismes nationaux de protection civile et de gestion des catastrophes pour renforcer la chaîne d'alerte et assurer ainsi une réaction optimale des populations, et souligner l'importance de la participation de ces organismes aux instances régionales techniques et de gouvernance relatives aux tsunamis ;
- continuer de renforcer la sensibilisation et la préparation aux tsunamis dans les communautés et auprès des autorités, par le biais d'activités de communication, de formation et d'information, de la planification des évacuations, d'exercices d'alerte aux tsunamis et de la mise à l'essai de programmes de reconnaissance tels que Tsunami Ready ;
- densifier les réseaux marégraphiques capables de détecter des tsunamis ainsi que les réseaux sismiques, en particulier à proximité des sources tsunamigènes ;
- mettre en place un taux d'échantillonnage de 1 échantillon/seconde ou plus sur les marégraphes afin d'enregistrer et de transmettre les données sur la forme des vagues de tsunami causées par toutes les sources sismiques et non sismiques ;
- recommander aux autorités nationales et aux opérateurs de stations de partager les données sismiques et marégraphiques, les données GNSS et les autres types de données existants, y compris leurs métadonnées, en temps réel ou quasi réel, avec les prestataires de services relatifs aux tsunamis et les centres nationaux d'alerte aux tsunamis, pour une alerte rapide aux tsunamis plus efficace et plus complète au niveau mondial ;
- intégrer des données bathymétriques et altimétriques côtières en haute résolution dans un modèle de relief côtier unifié et développer la communication de ces données afin d'améliorer la caractérisation des tsunamis et autres aléas et risques côtiers, et plaider en faveur de cette démarche par l'intermédiaire de l'Organisation hydrographique internationale (OHI) et des commissions hydrographiques régionales ;
- inscrire les centres nationaux d'alerte aux tsunamis et les points focaux pour l'alerte aux tsunamis au Registre des autorités d'alerte de l'OMM par l'intermédiaire des représentants

permanents des pays auprès de cette organisation, pour donner suite aux lettres circulaires de l'OMM ;

- demander à leurs centres nationaux d'alerte aux tsunamis de publier les alertes nationales aux tsunamis dans le format du protocole d'alerte commun (PAC) en complément de leurs messages actuels, le cas échéant, ce qui permettrait de diffuser largement ces informations d'alerte, ainsi que d'autres alertes sur les risques côtiers, et de les rendre disponibles sur de multiples plates-formes telles que le système mondial d'alerte météo (GMAS) en cours de développement par l'OMM.

Le Groupe a recommandé au Conseil exécutif de la COI, à sa session de 2020, de donner instruction aux groupes intergouvernementaux de coordination (GIC) régionaux :

- de promouvoir l'édition 2020 de la Journée mondiale de sensibilisation aux tsunamis auprès des États membres et de mettre en avant l'objectif (e) du Cadre de Sendai, qui vise à augmenter nettement, d'ici à 2020, le nombre de pays dotés de stratégies nationales et locales de réduction des risques de catastrophe ;
- de poursuivre les activités pilotes de Tsunami Ready reconnues par la COI, notamment en réalisant des enquêtes sur la situation, l'intérêt et l'avis des États membres à l'égard de la mise en œuvre de ce programme ;
- d'accroître la participation des organismes de protection civile à leurs activités courantes ;
- d'étudier les procédures et les meilleures pratiques pour faire face aux tsunamis de source locale, sur la base des principes directeurs énoncés par le Système d'alerte aux tsunamis dans le Pacifique et révisés par le Système d'alerte aux tsunamis et de mitigation dans l'océan Indien (Document en cours d'élaboration : *Local-Source Tsunami Response Best Practice*, version 1).

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

Le Groupe a recommandé au Conseil exécutif de la COI, à sa session de 2020, de prendre les mesures suivantes :

- prolonger les fonctions du TOWS-WG et de ses équipes spéciales sur (i) la gestion et la préparation en cas de catastrophe et (ii) les opérations de veille aux tsunamis, 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.

Le Groupe a remercié l'Office météorologique japonais (JMA) et le Centre consultatif sur les tsunamis dans le Pacifique Nord-Ouest (NWPTAC) d'avoir fourni des services intérimaires pour la mer de Chine méridionale depuis 2006, jusqu'à ce que le SCSTAC devienne pleinement opérationnel le 5 novembre 2019.

Le Groupe a pris note avec satisfaction des informations présentées par l'OMM sur les changements intervenus au sein de l'Organisation et sur le Conseil collaboratif mixte OMM-COI nouvellement établi.

Resumen

La 13ª 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-XIII) se celebró los días 20 y 21 de febrero de 2020 en la Sede de la UNESCO, en París, 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 (26 de junio-4 de julio de 2019, París).

El Grupo reconoció que seguía existiendo una gran brecha de capacidad para proporcionar previsiones de tsunami precisas y aplicables a las comunidades costeras de mayor riesgo. El Grupo describió de forma exhaustiva esa laguna mediante una combinación de publicaciones revisadas por homólogos, conferencias y consultas durante los dos últimos años.

El Grupo reconoció además que el Decenio de las Naciones Unidas de las Ciencias Oceánicas para el Desarrollo Sostenible ofrecía una oportunidad única de abordar y posiblemente colmar esa laguna aprovechando las nuevas plataformas, técnicas y/o infraestructuras de detección para detectar y medir rápidamente los tsunamis, en cuanto se forman.

El Grupo pidió que el Consejo Ejecutivo de la COI, en su reunión de 2020, abogara enérgicamente por la puesta en marcha de una iniciativa emblemática en el marco del Decenio de las Naciones Unidas de las Ciencias Oceánicas para el Desarrollo Sostenible destinada a subsanar esa flagrante brecha de capacidad en los servicios mundiales de predicción y alerta contra los tsunamis.

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

- los dos ejercicios realizados (CARIBE WAVE 2019 y PACWAVE 2019) y las pruebas de comunicación periódicas llevadas a cabo;
- los avances continuos en la transmisión de los resultados de las simulaciones de tsunamis y las pruebas de comunicación a la Organización Meteorológica Mundial (OMM) y las mejoras de las tasas de difusión de los mensajes de alerta del Sistema de Alerta contra los Tsunamis y Atenuación de sus Efectos en el Océano Índico (IOTWMS);
- la certificación obtenida por varias comunidades en el marco de Tsunami Ready, entre ellas Omoa y Tornabe (ambas de Honduras), Bluefields y las Islas del Maíz (ambas de Nicaragua), así como el proceso en curso para la certificación de al menos otras diez comunidades;
- la acreditación del Instituto Português do Mar e da Atmosfera (IPMA) como proveedor de servicios sobre tsunamis en el marco del NEAMTWS;
- el inicio de las operaciones del Centro de Asesoramiento sobre los Tsunamis en el Mar de China Meridional (SCSTAC), albergado en el Centro Nacional de Previsiones sobre el Medio Marino de China (SCSTAC/NMEFCel 5 de noviembre de 2019);
- el inicio de las operaciones, con carácter experimental, del Centro de Asesoramiento sobre los Tsunamis de América Central (CATAC), albergado en el Instituto Nicaragüense de Estudios Territoriales (INETER), en agosto de 2019;
- el simposio internacional sobre las enseñanzas extraídas de los tsunamis que se produjeron en 2018 en Palu y el estrecho de la Sonda, organizado en Yakarta (Indonesia), del 26 al 28 de septiembre de 2019 (véase el [resumen](#));

- los esfuerzos desplegados por Indonesia para densificar su red nacional de detección en respuesta a los fenómenos acaecidos en Palu y el estrecho de la Sonda;
- los esfuerzos realizados para fortalecer la resiliencia a los tsunamis en la zona de Makran mediante el proyecto “Fortalecimiento de la alerta temprana contra los tsunamis en la región noroccidental del Océano Índico mediante la cooperación regional”, financiado por la Comisión Económica y Social para Asia y el Pacífico (CESPAP).

El Grupo aprobó los cambios introducidos en el mapa de la zona de servicio (véase el apéndice 4 del Anexo IV).

El Grupo recomendó al Consejo Ejecutivo que, en su reunión de 2020, alentara a los Estados Miembros a:

- mantener y reforzar el apoyo técnico y financiero a los sistemas de alerta contra los tsunamis y otros peligros costeros en sus regiones respectivas;
- destacar la función que desempeñan sus organismos nacionales de protección civil y gestión de desastres en el fortalecimiento de la cadena de alerta para garantizar una respuesta óptima de la comunidad, y subrayar la importancia de la participación de sus organismos en foros regionales sobre gobernanza y aspectos técnicos en materia de tsunamis;
- seguir reforzando la sensibilización y preparación acerca de los tsunamis en las comunidades y entre las autoridades mediante la comunicación, la planificación de las evacuaciones, las simulaciones de tsunamis, la formación, la información, y los programas piloto de certificación, como Tsunami Ready;
- densificar las redes de medición del nivel del mar capaces de detectar tsunamis, así como la red sísmica, en particular cerca de las fuentes tsunamigénicas;
- establecer una tasa de muestreo de 1 muestra/segundo o más en los mareógrafos para registrar y transmitir datos sobre la forma de las olas de tsunami causadas por todas las fuentes sísmicas y no sísmicas;
- recomendar que las autoridades de los Estados Miembros y los operadores de las estaciones difundan los datos sísmicos y sobre el nivel del mar, los datos del GNSS y otros tipos de datos existentes, incluidos sus metadatos, en tiempo real o casi real, a los proveedores de servicios sobre tsunamis y centros nacionales de alerta contra los tsunamis para que la alerta temprana contra los tsunamis sea más eficaz y completa a escala mundial;
- integrar los datos batimétricos y altimétricos costeros de alta resolución en un modelo de relieve costero unificado y ampliar el intercambio de datos para mejorar la caracterización de los tsunamis y otros peligros y riesgos costeros, y abogar también en ese sentido a través de la Organización Hidrográfica Internacional y las comisiones hidrográficas regionales;
- inscribir los centros nacionales de alerta contra los tsunamis y los puntos focales de alerta contra los tsunamis en el Registro de Autoridades de Alerta de la OMM por conducto de los representantes permanentes de los países de la OMM, para dar seguimiento a las circulares de la OMM;
- pedir a sus centros nacionales de alerta contra los tsunamis que publiquen las alertas nacionales de tsunami en el formato del protocolo común de alerta (PCA) como complemento de sus mensajes actuales, según proceda; ello permitirá difundir ampliamente esa información de alerta, así como otras alertas de peligros costeros, y

ponerlas a disposición en múltiples plataformas, como el sistema mundial de alerta meteorológica (GMAS) que está creando la Organización Meteorológica Mundial.

El Grupo recomendó al Consejo Ejecutivo que, en su reunión de 2020, encargara a los grupos intergubernamentales de coordinación (GIC) regionales lo siguiente:

- promover la edición de 2020 del Día Mundial de la Concienciación sobre los Tsunamis entre sus Estados Miembros y poner de relieve la meta e) del Marco de Sendái consistente en *incrementar considerablemente el número de países que cuentan con estrategias de reducción del riesgo de desastres a nivel nacional y local para 2020*;
- continuar las actividades piloto de Tsunami Ready con el reconocimiento de la COI de la UNESCO, comprendida la realización de encuestas sobre la situación, el interés y las reacciones de los Estados Miembros respecto de la ejecución de Tsunami Ready;
- aumentar la participación de los organismos de protección civil en sus actividades ordinarias;
- examinar los procedimientos y las mejores prácticas de respuesta a los tsunamis de origen local sobre la base de las directrices proporcionadas por el Sistema de Alerta contra los Tsunamis en el Pacífico y revisadas por el Sistema de Alerta contra los Tsunamis y Atenuación de sus Efectos en el Océano Índico (documento en curso de elaboración: [Local-Source Tsunami Response Best Practice](#), versión 1).

El Grupo aceptó los informes de los equipos de trabajo de los GIC sobre gestión de desastres y preparación y sobre actividades de vigilancia, y **encargó** a ambos equipos de tareas que prosiguieran sus esfuerzos de vigilancia y respuesta a los tsunamis generados por fuentes no sísmicas y sus esfuerzos con miras a su posible integración en las operaciones de vigilancia de tsunamis.

El Grupo recomendó al Consejo Ejecutivo que, en su reunión de 2020, 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, y ii) actividades de vigilancia de los tsunamis, partiendo del mandato que figura en la resolución XXIV-14 de la COI (para el TOWS-WG), el anexo II del documento IOC/TOWS-WG-VI/3 (para el equipo de trabajo sobre gestión de desastres y preparación), y el anexo II (apéndice I) del documento IOC/TOWS-WG-X/3 (para el equipo de trabajo sobre actividades de vigilancia de los tsunamis).

El Grupo expresó su reconocimiento al Organismo Meteorológico del Japón y al Centro de Asesoramiento sobre los Tsunamis del Pacífico Noroccidental (NWPTAC) por haber prestado servicios provisionales para el mar de China meridional desde 2006 hasta el inicio del pleno funcionamiento del SCSTAC el 5 de noviembre de 2019.

El Grupo tomó nota con reconocimiento de la información presentada por la OMM sobre sus cambios organizativos y sobre la Junta Mixta de Colaboración OMM/COI recientemente establecida.

Рабочее резюме

20-21 февраля 2020 г. в Штаб-квартире ЮНЕСКО в Париже, Франция, под председательством г-на Александра Фролова (заместитель председателя МОК) состоялось тринадцатое совещание Рабочей группы по системам предупреждения и смягчения последствий цунами и других опасных явлений, связанных с изменением уровня моря (РГ-СПЦО-XIII). 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 отметила существенную ограниченность возможностей в плане обеспечения наиболее цунамиопасных прибрежных территорий точными и актуальными оперативными прогнозами по цунами. В последние два года Группа использовала любые возможности для подробного разъяснения этой проблемы путем публикаций в научных журналах, а также обсуждения этого вопроса в рамках различных конференций и консультаций.

Группа отметила далее, что проведение Десятилетия ООН, посвященного науке об океане в интересах устойчивого развития, открывает уникальную возможность для привлечения внимания к проблеме ограниченных возможностей и поиска возможного ее решения с использованием современных платформ, методов и/или инфраструктуры дистанционного зондирования в целях оперативного обнаружения и оценки опасности цунами фактически в момент их формирования.

Группа просила Исполнительный совет МОК настоятельно рекомендовать в ходе своей очередной сессии в 2020 г. включение в программу Десятилетия науки об океане флагманской инициативы, направленной на устранение этой очевидной проблемы ограниченности потенциала служб прогнозирования и предупреждения о цунами по всему миру.

Группа с удовлетворением отметила результаты деятельности, осуществлявшейся в межсессионный период, а именно:

- проведены учения по проверке готовности к цунами («Карибская волна-2019» и «Тихоокеанская волна-2020»), кроме того, регулярно проводится тестирование систем оповещения;
- отмечен последовательный прогресс в вопросах обмена информацией о результатах учений по проверке готовности к цунами и о проверке систем оповещения со Всемирной метеорологической организацией (ВМО), а также улучшение показателей доставки предупредительных сообщений в СПЦСИО;
- несколько населенных пунктов (Омоа и Торнабе в Гондурасе, Блюфилдз и Корн-Айленд в Никарагуа) получили сертификаты «К цунами готов», еще более десятка проходят процедуру сертификации;
- Португальскому институту моря и атмосферы (ПИМА) присвоен статус аккредитованного провайдера данных слежения за цунами СПЦСВАСМ;
- с 5 ноября 2019 г. на базе Национального центра прогнозирования состояния морской среды (НЦПСМ) в полном объеме начал функционировать Консультативный центр по цунами в Южно-Китайском море (КЦЦЮОКМ);

- с августа 2019 г. на базе Никарагуанского института территориальных исследований (ИНЕТЕР) в режиме опытной эксплуатации функционирует Консультативный центр по цунами для региона Центральной Америки (КЦЦЦА);
- 26-28 сентября 2019 г. в Джакарте, Индонезия, состоялся международный симпозиум по обобщению опыта в связи с цунами 2018 г. в Палу и Зондском проливе (см. [итоговое заявление](#));
- в связи с событиями в Палу и Зондском проливе Индонезия предпринимает усилия по уплотнению своей национальной сети станций обнаружения;
- в рамках финансируемого ЭСКАТО проекта «Укрепление системы раннего предупреждения о цунами в северо-западной части Индийского океана на основе регионального сотрудничества» предпринимаются усилия по наращиванию потенциала противодействия цунами в районе Макранского побережья.

Группа одобрила внесение изменений в карту зоны обслуживания (см. добавление 4 к приложению IV).

Группа рекомендовала Исполнительному совету в ходе его сессии в 2020 г. призвать государства-члены:

- обеспечить поддержание и наращивание уровня технической и финансовой поддержки систем предупреждения о цунами и других потенциальных опасностях в прибрежной зоне в своих соответствующих регионах;
- обратить внимание национальных органов защиты гражданского населения/органов по предупреждению и ликвидации последствий стихийных бедствий на важность выполнения ими задач, связанных с укреплением системы предупреждения в целях обеспечения эффективного реагирования на уровне общин, а также подчеркнуть значимость участия указанных органов в работе региональных руководящих и технических форумов по цунами;
- продолжать информационно-просветительскую деятельность и усилия по повышению уровня готовности к цунами населения и органов власти посредством обмена информацией, планирования эвакуационных мероприятий, проведения учений по проверке готовности к цунами, организации обучения, подготовки информационных материалов и экспериментального внедрения программ сертификации, таких как Программа сертификации готовности к цунами;
- повышать плотность станций наблюдения за уровнем моря, а также сейсмических станций, особенно в цунамиопасных районах;
- установить на мареографах частоту замеров на уровне 1 замер/в сек. или выше в целях регистрации и передачи данных о волновой картине цунами как сейсмического, так и несейсмического происхождения;
- рекомендовать компетентным властям и операторам станций наблюдений государств-членов обмениваться имеющимися данными о сейсмичности, уровне моря, ГНСС и другими видами данных, включая их метаданные, в реальном или близком к реальному масштабе времени с провайдерами услуг по цунами и национальными центрами предупреждения о цунами в целях обеспечения более эффективного и обстоятельного повсеместного раннего оповещения о цунами;

- интегрировать прибрежные батиметрические данные в высоком разрешении и данные о рельефе суши в единую модель прибрежной зоны и расширять обмен данными в целях усовершенствования классификации цунами и других опасных явлений и рисков в прибрежных районах, а также распространять призывы к такой работе через Международную гидрографическую организацию и региональные гидрографические комиссии;
- регистрировать национальные центры предупреждения о цунами (НЦПЦ) и координаторов по предупреждению о цунами (КПЦ) в качестве органов по предупреждению в «Реестре органов ВМО по предупреждению» через национального постоянного представителя в ВМО и в соответствии с циркулярными письмами ВМО;
- обратиться к своим национальным центрам предупреждения о цунами с просьбой в соответствующих случаях распространять информацию национальных систем предупреждения о цунами в формате общего протокола оповещения (ОПО) в качестве дополнения к текущим сообщениям; это позволит обеспечить широкое распространение поступающей от систем предупреждения информации вместе с другими оповещениями об опасных явлениях в прибрежных районах, а также размещение этой информации на разнообразных платформах, таких как создаваемая Всемирной метеорологической организацией Глобальная система метеорологических оповещений (ГСМО).

Группа рекомендовала Исполнительному совету в ходе его сессии в 2020 г. поручить региональным межправительственным координационным группам:

- выступить в поддержку проведения в 2020 г. государствами-членами Всемирного дня распространения информации о проблеме цунами (ВДИПЦ) и привлечь их внимание к цели «Е» Сендайской рамочной программы действий, в которой предусмотрено *к 2020 г. значительно увеличить число стран, принявших национальные и местные стратегии снижения риска бедствий*;
- продолжать осуществление пилотных мероприятий по Программе сертификации готовности к цунами (ЮНЕСКО-МОК), в том числе проведение обзоров положения дел в государствах-членах, оценку их заинтересованности и анализ их замечаний, касающихся осуществления этой программы;
- расширять участие органов защиты гражданского населения в плановых мероприятиях;
- обсудить практические подходы и передовой опыт реагирования на цунами местного происхождения, руководствуясь методическими рекомендациями, подготовленными в рамках Системы предупреждения о цунами в Тихом океане и пересмотренными в Системе предупреждения о цунами и смягчения их последствий в Индийском океане (*в настоящее время готовится первая версия документа под названием «Передовой опыт в области реагирования на цунами, возникающие под воздействием местных сейсмических очагов»*).

Группа утвердила доклады межсессионных целевых групп МКГ (по предупреждению и ликвидации последствий бедствий и обеспечению готовности к ним и по наблюдению за цунами) и **поручила** обеим группам продолжать усилия, направленные на мониторинг и принятие мер реагирования в отношении цунами несейсмического происхождения с возможным включением этого аспекта в деятельность по наблюдению за цунами.

Группа рекомендовала Исполнительному совету утвердить в ходе его сессии в 2020 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 ИОС/TOWS-WG-VI/3, приложение II (для ЦГ-ЛПГ) и ИОС/TOWS-WG-X, добавление 1 к приложению II (для ЦГ-НЦ).

Группа выразила признательность Японскому метеорологическому агентству и Консультативному центру по цунами для северо-западной части Тихого океана (КЦЦСЗТО) за оказание им на временной основе в период с 2006 г. до начала полномасштабной работы КЦЦЮКМ 5 ноября 2019 г. услуг в районе Южно-Китайского моря.

Группа с удовлетворением приняла к сведению представленную ВМО информацию об организационных изменениях и о недавнем создании Объединенного совета по сотрудничеству ВМО-МОК.

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 work tasks assigned to Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG) by the IOC Assembly at its Thirtieth Session (IOC-XXX/3) including the further enhancements of the tsunami warning system and addressing tsunamis triggered by non seismic sources. He also stressed the need to consider how the tsunami community can participate effectively in the UN Ocean Decade — which is a challenge and also an opportunity. Finally, he highlighted the governing body reforms of WMO (World Meteorological Organization), the abolition of WMO-IOC Joint Technical Commission for Oceanography and Marine Meteorology and the creation of the WMO-IOC Joint Collaborative Board which will provide strategic recommendations to the governing bodies of WMO and IOC on joint initiatives and activities. In closing he wished for a productive meeting.

2. Mr Vladimir Ryabinin, Executive Secretary of IOC, provided welcoming remarks. He highlighted the importance of oceanography and the science behind sustainable development, and reflected over the challenges that the oceanographic community face including budget constraints and lower sustainability of the ocean observing networks compared with the meteorological observing networks. He highlighted the on-going negotiations to develop an international legally binding instrument under the United Nations Convention on the Law of Sea on the conservation and sustainable use of marine biological diversity in areas beyond national jurisdiction. A potential outcome of the negotiations may be a call for more sustained support for oceanography and sustained observations. He emphasized the need for a holistic view when facing the community challenges. He also mentioned IOC's coordinating role in developing an Implementation Plan for the United Nations Decade of Ocean Science for Sustainable Development. The work has been underway since 2018 and the Plan will go out for review in March 2020. He summarized the paradigm of the Decade as follows:

“The need to cover technological and research gaps in our science capacity. The gaps are in mapping, hazards, in ocean data, understanding ecosystem, ocean observing system, capacity development, taking this as a part of earth system science. There is a need to improve policies and management of the ocean through existing mechanisms such as via Marine Spatial Planning and Integrated Coastal Area Management and good policies for the ocean”.

In closing he stressed that tsunami is an important element for the Decade. A big-project proposal has been developed by the community for tagging on pressure and seismic sensors on underwater communication cables and thereby strengthening the tsunami detection network. He also encouraged further steps to involve of national civil protection agencies in the tsunami preparedness work, and the further development of the Tsunami Ready program.

1.2 ADOPTION OF AGENDA

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

1.3 WORKING ARRANGEMENTS

4. Mr Thorkild Aarup 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-unesco.org/tows-wg13>.

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)

5. Ms Silvia Chacon 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 two recent events registered in the Caribbean. A Mw 7.7 earthquake on 28 January 2020, in the Caribbean Sea, 123 km NNW of Lucea, Jamaica, with a recorded maximum height of 11 cm. in Cayman Islands. In addition, an Mw 6.4 earthquake 14 km SE of Guanica, Puerto Rico, with a maximum height of 6 cm. The first one, which happened in the Cayman Ridge, triggered the first PTWC Threat Bulletin since 2018 (Honduras). For the second one in Puerto Rico people evacuated (self-evacuation and some activated sirens).
6. She reported on the Fourteenth session of the ICG/CARIBE-EWS hosted in Punta Leona, Costa Rica, 8–11 April 2019, ([ICG/CARIBE-EWS-XIV/3](#)) and recalled that ICG/CARIBE-EWS is currently organized with a Board of Officers, four Working Groups (WGs), five Task Teams (TTs) and one Group of Experts for the period 2019–2020. Ms Chacon summarised the main elements of the reports of the four Working Groups. She highlighted that Working Group 1 reminded that gaps on sea level coverage still need to be addressed, and that an Experts Meeting on Tsunami Sources for the Lesser Antilles was hosted by France (Martinique) and will be reported soon including in the online Caribbean and Adjacent regions Tsunami Sources (CATSAM) maintained by the National Centers for Environmental Information of the US National Oceanic and Atmospheric Administration (NCEI/NOAA) through Working Group 2.
7. She reported that Working Group 3 noted that a sub-regional Tsunami Service Provider (TSP) is being developed by Nicaragua, with the name Central America Tsunami Advisory Center (CATAC) that will work under subscription for the Caribbean, issuing products in Spanish. Working Group 4 developed an inventory of tsunami evacuations signs and symbols used in the region as well as internationally (including the ISO 20712) and is working with Working Group 2 on the Task Team on Tsunami Evacuation Maps.
8. Ms Chacon also reported that Tsunami Ready recognition process was completed in seven (7) Caribbean communities: Bluefields (Nicaragua), Carriacou and Petite Martinique (Grenada), Corn Islands (Nicaragua), Fort Liberte (Haiti), Omoa (Honduras), St. Patricks (Grenada) and Tornabe (Honduras). Five (5) more communities have initiated the recognition process through a DIPECHO project in Antigua & Barbuda, Barbados, Dominican Republic, St Vincent & the Grenadines and Trinidad and Tobago. Two (2) additional communities, one in Belize and one in St Vincent and the Grenadines (St. George), are in the same process with support of United States through the NOAA/NWS Caribbean Tsunami Warning Programme with USAID (United States Agency for International Development) funds.
9. Ms Chacon recalled that a Task Team on Volcanic Sources for Tsunamis was created in 2016 after the volcanic crisis of submarine volcano Kick'em Jenny in 2015. The work performed by this Task Team led to the use of a volcanic scenario for the Caribe Wave exercise 2019, which became more relevant after the Sunda strait tsunami in November 2018.
10. Ms Chacon informed that over 700,000 people from Bermuda through Brazil and across the entire Caribbean participated in the Caribe Wave 19 exercise held the 14 March 2019 ([IOC/2018/TS/141](#)) with two scenarios for the Member States to choose from: an earthquake located off the North Panama Deformed Belt and a simulated volcanic source at Kick'em

Jenny. She reported that a Caribe Wave 20 exercises is planned on 19 March 2020 with two scenarios in Jamaica and in Portugal.

2.1.2 Indian Ocean Tsunami Warning and Mitigation System (IOTWMS)

11. Mr Pattabhi Rama Rao made a presentation on IOTWMS, on behalf of the Chair Prof. Dwikorita Karnawati. He provided an overview of the structure of the ICG/IOTWMS which comprises a Steering Group, two technical Working Groups, one sub-regional Working Group, a Task Team for the IOWave20 exercise, a Task Team on Scientific Tsunami Hazard Assessment for the Makran Subduction Zone and a Task Team on Tsunami Preparedness for a near-field tsunami hazard. IOTWMS Secretariat is supported by funding from the Bureau of Meteorology, Government of Australia, and the IOTIC (Indian Ocean Tsunami Information Center) is supported by BMKG (Meteorology, Climatology, and Geophysics Agency) until 2022 under a partnership agreement between with IOC/UNESCO. The [ICG/IOTWMS-XII](#) session was organized in Kish Island, Islamic Republic of Iran, during 9–12 March 2019, back to back with the Expert Consultation on Scientific Tsunami Hazard Assessment of the Makran Subduction Zone on 8 March 2019.
12. There are 28 Member States in the IOTWMS and three operational Tsunami Service Providers (Australia, India and Indonesia) providing interoperable tsunami threat information to the National Tsunami Warning Centres (NTWCs). The NTWCs have sovereign responsibility for provision of detailed tsunami threat information for their coastal regions. Tsunami detection, warning and dissemination has been strengthened and the performance of the TSPs against Key Performance Indicators (KPI) is monitored on a regular basis. Routine communications tests are conducted every June and December to ensure operational lines of communication between TSPs and the NTWCs.
13. On Tsunami Risk, Community Awareness and Preparedness, Mr Rao reported progress made in piloting of the UNESCO/IOC Tsunami Ready in six communities in India and one community in Oman, supported by the Indian Ocean Tsunami Information Centre (IOTIC) and the Secretariat. A national training on UNESCO/IOC Tsunami Ready was organized in Hyderabad, India, during 10–14 December 2019, followed by verification visit to two candidate Tsunami Ready communities in Odisha province. IOWave20 exercise is scheduled in October 2020.
14. The IOTWMS is implementing a UNESCAP funded project on “Strengthening Tsunami Early Warning in the North West Indian Ocean region through Regional Cooperation”. Project activities were held in Muscat, Oman, (1–6 September 2019) and Hyderabad, India, (2–4 December 2019) to enhance early warning chains of Member States and finalize a work plan for development of a Probabilistic Tsunami Hazard Assessment (PTHA) for the Makran Region.
15. A symposium on lessons learnt from the 2018 Palu and Sunda Strait tsunamis was organized during 26–28 September 2019 in Jakarta, Indonesia, which highlighted the need for enhancing community preparedness for near-field tsunamis and strengthening warning systems to be able to warn for tsunamis caused due to landslides and volcanic activities. A workshop on strengthening tsunami early warning to critical infrastructure during 20–22 October 2019 was also organized in Jakarta, Indonesia, as part of the World Tsunami Awareness Day (WTAD) in 2019.
16. Mr Rao reported that seismic and sea level monitoring networks including tide gauges and tsunami buoys have expanded in the Indian Ocean since 2004. However, there are still several gaps in several regions including the Makran, either due to non-availability of stations or due to data from existing stations not being openly shared. He reported that the ICG/IOTWMS Steering Group prepared a communique urging all countries and institutions to

adopt and practice open data policies for real-time seismic, GNSS and sea-level data to support faster, more accurate and more reliable tsunami source characterisation and warning.

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

17. Mr François Schindelé reported on the ICG/NEAMTWS activities for the intersessional period on behalf of the Chairperson Mr Gerassimos Papadopoulos. He pointed out that the city of Cannes hosted the ICG/NEAMTWS-XVI session in France from 2 to 4 December 2019. The mayor and deputy mayor of the city of Cannes strongly supported the meeting. He highlighted the efforts and progress undertaken by the city of Cannes to mitigate tsunamis. Many of these efforts represents a first among municipalities in France and Cannes is a beacon or pilot town in that respect.
18. The Secretariat carried out an outreach communication in an effort to close the existing gaps concerning nominations for Tsunami National Contacts (TNCs) and Tsunami Warning Focal Points (TWFPs) in the NEAM region. This also included updating Member States subscription to Tsunami Service Providers (TSPs) to ensure more countries are receiving tsunami messages, noting that countries in NEAM region need to subscribe to TSPs of their interest to receive their tsunami messages.
19. The Instituto Português do Mar e da Atmosfera (IPMA, Portugal) was accredited as a Tsunami Service Provider (TSP), becoming the fifth TSP in NEAM region (CENALT – France, INGV – Italy, NOA – Greece, KOERI – Turkey). There are now at least two TSPs for each sub-basin in NEAM region.
20. Several meetings and national tsunami exercises were organized in 2019 in France, Greece, Israel, Italy and Turkey in line with the World Tsunami Awareness Day.
21. As part of the 'Tsunami Last Mile' research project funded by the European Commission (EC) through the Joint Research Center (JRC), an earthquake and tsunami preparedness exercise was organized in the city of Kos, Greece. In Bodrum, Turkey, tsunami awareness raising and preparedness seminars and one table-top exercise were carried out.
22. Mr Schindelé reported that the ICG/NEAMTWS decided to continue the merged activities of Working Group 2 on Seismic and Geophysical Measurements and Working Group 3 on Sea Level Data Collection and Exchange, Including Offshore Tsunami Detection and Instruments.
23. The ICG/NEAMTWS is preparing a new Strategy and Implementation Plan. The Strategy and Implementation Plan will be presented at the Seventeenth session of ICG/NEAMTWS.
24. The ICG/NEAMTWS-XVI decided to conduct NEAMWave20 from 2 to 4 November 2020.

2.1.4 Pacific Tsunami Warning and Mitigation System (PTWS)

25. Mr Wilfried Strauch (Nicaragua), Chair of the Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System (ICG/PTWS), reported for ICG/PTWS. He recalled the structure of the ICG/PTWS with three technical Working Groups, four regional Working Groups, six Task Teams and the PTWS Steering Committee.
26. He also recalled that three Tsunami Service Providers (TSPs) serve the PTWS: the Pacific Tsunami Warning Center (PTWC), the North West Pacific Tsunami Advisory Center

(NWPTAC), and the South China Sea Tsunami Advisory Center (SCSTAC). The latter initiated full operations on 5 November 2019.

27. Mr Strauch reported on the twenty-eighth session of the ICG/PTWS (ICG/PTWS-XXVIII) hosted by Nicaragua, from 2 to 5 April 2019, attended by 63 participants from 21 countries, and 4 Observer organizations.
28. Mr Strauch highlighted the following key recommendations and decisions of ICG/PTWS XXVIII:
- Establishment of a Working Group 2 Task Team to propose minimum competency levels for National Tsunami Warning Centre (NTWC) operations staff;
 - Establishment of a Working Group 2 Task Team to propose an optimal multi-instrument sensor network that integrates existing and emerging techniques and sensor technologies, for tsunami detection and characterisation;
 - Decision to organize and conduct the exercise Pacific Wave 2020 (PacWave 2020) in the months September to November 2020; to be conducted as a series of regional exercises organised through the PTWS regional working groups;
 - Decision to commence the full operation of the South China Sea Tsunami Advisory Center (SCSTAC) on 5 November 2019 along with a change of NWPTAC's Area of Service. Consequently, NWPTAC's (JMA) stopped the interim service for the South China Sea region in November 2019 when the full operation of SCSTAC started.
 - Decision to support the efforts and progress made by Nicaragua in the creation of the Central American Tsunami Advisory Centre (CATAC), as a tsunami service provider (TSP) within the framework of the ICG/PTWS;
 - Decision to support the proposal to begin sending trial tsunami messages as of August 2019, based on the progress made in capacity-building for the establishment of the Central American Tsunami Advisory Centre (CATAC);
 - Recommendation to Member States with GNSS data to investigate the means of sharing this data in real time, with a view towards and benefits of improved tsunami impact forecasts for coastlines particularly for near-field events.
29. He noted continued support from the European Union to develop tsunami preparedness in Central America with funding from the Humanitarian Aid department of the European Commission (ECHO) through UNESCO San Jose Office and IOC. He highlighted these activities have been very successful by helping developing national Standard Operating Procedures (SOPs), community level SOPs or Response Plans, drills and Tsunami Ready recognitions for a total of 10 communities in Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama. He also noted the support provided by the Office of U.S. Foreign Disaster Assistance within the United States Agency for International Development (USAID/OFDA).
30. Mr Strauch reported that the PTWS has organized three Hazard Assessment Experts meetings: Tsunami Hazard in Central America: Historical Events and Potential Sources, San José, Costa Rica, 23–24 June 2016 ([IOC/2018/WR/278](#)); [Scientific meeting of experts to understand tsunami sources, hazards, risk and uncertainties associated with the Tonga-Kermadec Subduction Zone](#), 29 October–2 November 2018, Wellington, New Zealand; and the [Scientific meeting of experts to understand tsunami sources, hazards, risk and uncertainties associated with the Colombia-Ecuador Subduction Zone](#), 27–29 January 2020, Guayaquil, Ecuador. He noted that the PTWS has discussed about how to address all possible

tsunami sources including slow earthquakes, volcanic processes, submarine landslides, aerial landslides, meteorological processes and meteorites.

31. He reported that the twenty-eighth session of the ICG/PTWS approved a statement ([Recommendation ICG/PTWS-XXVIII.6](#)) on the UN Decade of Ocean Science for Sustainable Development (2021–2030).

2.2 REPORT OF NON-IOC BODIES

2.2.1 World Tsunami Awareness Day (UNDRR)

32. Ms Brigitte Leoni reported on this item.
33. She first highlighted activities for the 2019 edition of World Tsunami Awareness Day (WTAD). These included: (i) production of a video from tsunami and earthquake drills and vertical evacuation structure integrated into an elementary school in Westport (Washington, USA); (ii) a social media campaign in Spanish developed in collaboration with the Coordination Center for the Prevention of Natural Disasters in Central America and the Dominican Republic (CEPRENAC); and (iii) awareness raising via the UNDRR (United Nations Office for Disaster Risk Reduction) regional office in Panama in regards to Caribe Wave 2019.
34. At least 12 countries reported to have commemorated the WTAD in 2019 in Asia. The Government of Indonesia, with support from UNESCO/IOC, organized an international symposium on the lessons learnt from the 2018 tsunami in the country, while Bangladesh organized a roundtable discussion on WTAD. Japan, New Zealand and China also marked the Day with special activities.
35. The WTAD campaign in 2019 was a social media campaign with a real peak between 13 October and 5 November. Many partners used the social media tools and materials developed by UNDRR to commemorate the Day. More than 10 videos were produced and 15 digital cards.
36. Many more countries are now commemorating the Day and using it as an opportunity to raise awareness on other hazard risks. This is the case in Americas and also in Asia. More effort is needed to raise awareness in Africa (Maghreb) and Europe. UNDRR will continue to work with partners and the broadcasting unions to address this next year. UNDRR will also take the opportunity of the Sendai target (e) campaign to highlight countries in the Caribbean which are Tsunami Ready.
37. For 2020, the aim is to increase the WTAD visibility on social platforms and in political forums.
38. The social media platforms will include (Twitter, Facebook, LinkedIn) and Prevention Web to feature tsunami risk, concentrating particularly on building resilient infrastructure. Main hashtags: #TsunamiDay #PlanE (Sendai Framework Target (e)).
39. For 2020 the WTAD will highlight countries and cities which are Tsunami Ready and which have tsunami plans in place to enhance Sendai Target (e) to :
Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020.
40. In 2020, UNDRR will continue working with its partners and Member States to increase tsunami risk awareness and preparedness in particular in the Maghreb region and Africa (Seychelles, Mauritius).

41. Main message is: Tsunami risk should be incorporated in national and local disaster risk reduction strategies and early warning, preparedness and education policies.
42. Planned events include: (i) Interact with major global 2020 events such as the launch of the UN Ocean Decade, COP 26 meeting, 2020 Olympics, Dubai Expo; (ii) organize awareness events in New York (USA), Japan High School Students Summit, the DRR Regional Platform (Jamaica) and elsewhere; (iii) UNDRR will work with IOC/UNESCO, and other partners to document and highlight efficient tsunami plans in place; and (iv) UNDRR will commemorate the 5 years of WTAD at the Dubai Expo 2020 (TBC).
43. A range of stories, both print, TV, radio and social media (Tsunami Ready), will be developed. Efforts will also focus on continued development of a global DRR media network to heighten awareness of good practices to reduce hazard risks including tsunami risk.
44. For WTAD various communications assets will be made available via the UNDRR web page (e.g. videos; Banners and roll ups).
45. In closing, Ms Leoni encouraged participants and ICGs to inform UNDRR in advance of planned WTAD 2020 activities so they can be promoted via the UNDRR on the various platforms.
46. The Group welcomed plans for: (i) WTAD 2020; (ii) collaboration with broadcasting unions on DRR; and (iii) development of a curriculum for DRR reporting and in-country training of journalists on DRR matters. The Group also emphasized the potential for collaboration with UNESCO's International Programme for the Development of Communication in developing the mentioned DRR curriculum.

2.2.2 World Meteorological Organization (WMO)

47. Mr David Thomas, Mr Cyrille Honoré and Ms Sarah Grimes reported on this item.
48. The presentation centered on the following topics: (i) Data delivery and information systems; (ii) the Register of Alerting Authorities; (iii) the MHEWS International Conference & UNDRR Global Platform 2019; (iv) WMO governance structure reform; (v) the Coastal Inundation Forecasting Demonstration Project; and (vi) the Global Multi-Hazard Alert System.
49. Mr Thomas first highlighted the results from the report of IOTWMS communication test on 12 June 2019. The GTS average reception rate was 78%, which is the highest in all communication tests since the 81% recorded in the December 2014 (noting that a rate of 83% was recorded in the exercise Indian Ocean Wave 18 (IOWave18) held in September 2018). Eighteen (18) of the 22 National Tsunami Warning Centres received GTS messages including Yemen which had not received GTS messages since the June 2016 test. Bangladesh, Comoros, Madagascar, and United Arab Emirates did not receive any GTS messages (noting that Madagascar have no GTS connection). Tanzania received the GTS messages sent by TSP India only. GTS message delay times continued to be low in this test, with most messages received within 1–3 minutes of issuing. However, India experienced delays of around 1 hour in receiving 3 GTS messages. Concerning SMS delivery then this typically ranges within 1 to 5 minutes. The longest delay was 16 minutes.
50. For the GTS, there has been an observed improvement in delivery rate and delay. The GTS delivery rate was lower than for email, but similar as for SMS. The GTS delay was similar to email, but faster than SMS. However, for a guaranteed delivery service, David Thomas did express concern about the delays and non reception still being too high. There will be a need for the WMO Global Information System Centres (GISCs) to explore errors and report on them specifically. In light of the improvements that have been demonstrated for the Indian Ocean,

David Thomas encouraged other ICGs to inform him about their forthcoming communication tests.

51. Mr Thomas and Mr Cyrille Honoré briefly informed about the WMO Register of Alerting Authorities. The background for this register has been provided at the Eleventh session of TOWS-WG (see also <https://etrp.wmo.int/mod/url/view.php?id=10870>). He emphasized that tsunamis come under the CAP definition GEO, and it is thus difficult to filter them for reporting on who is the tsunami authority. It is recommended that TSPs and National Tsunami Warning Centres include tsunami in their authorisation abstract. David Thomas acknowledged that few NTWCs have registered. A review of the register functionalities, including administration and access is under consideration, possibly taking the opportunity of the new WMO Community Platform. See also further comments made under [item 3.1](#).
52. Mr Honoré reported on the Second Conference on Early Warning and Early Action towards Sustainable, Resilient and Inclusive Societies (13–14 May 2019, WMO Headquarters, Geneva, Switzerland, <https://mhews.wmo.int/en>). The event was organized in partnership with the International Network for Multi-Hazard Early Warning Systems (IN-MHEWS)—an informal group of 19 organizations which also comprises of UNESCO and IOC. IOC/UNESCO contributed actively to the conference in regards to speakers, agenda and content. The MHEWS conference was a preliminary event for the UNDRR Global Platform for Disaster Risk Reduction (13–17 May 2019)
53. The outcomes from the MHEWS conference were presented at the Global Platform meeting the same week and highlighted the benefits and needs: (i) to align flexible governance, investments, capacity development building on measured benefits; (ii) to ensure that those at risk are integral part of MHEWS design and operations; (iii) to leverage innovative and advanced science and technology for operations and applications; (iv) to further advocate for the benefits and improvement of MHEWS worldwide. The outcomes are elaborated further in the proceedings (https://www.unisdr.org/files/66637_proceedingsen.pdf).
54. Mr Honoré and Ms Sarah Grimes provided an update on the WMO's efforts to reform its governing structures. There are implications for the joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM). The WMO Congress and IOC Assembly agreed in 2019 to: (i) disband JCOMM; (ii) form WMO-IOC Joint Collaborative Board (JCB); and (iii) establish a GOOS node office at WMO.
55. The WMO-IOC JCB will: (i) provide a high level coordination and strategic mechanism for engagement between WMO and IOC and their joint activities (though with no decision making); (ii) ensure JCOMM activities continue; and (iii) advise broadly on all connected/complementary activities (not just former JCOMM activities). The immediate tasks will be: (i) to ensure functional connections JCOMM to new structures and refine evolving GOOS governance; (ii) to develop a joint WMO-IOC Strategy (by mid 2021); and to organize the first face to face meeting – March 2020 (Geneva).
56. Ms Grimes reminded that the Coastal Inundation Forecasting Demonstration Project (CIFDP) has been reported on at previous TOWS-WG meetings. Four sub-projects in Bangladesh, Caribbean, Indonesia, and Fiji have now been completed and are operational and produce early warnings in the countries. An independent review of CIFDP project has been carried out (https://jcomm.info/index.php?option=com_content&view=article&id=373) and was submitted to the 18th WMO Congress. The CIFDP as a concept was 'deemed successful' as many sources and aspects of coastal inundation were included, but it was noted in the review that a link with the tsunami early warning was missing and should be considered.
57. The WMO Congress decided that the project should be continued as the Coastal Inundation Forecasting Initiative (CIFI). WMO Member States and in particular Pacific Islands

SIDS recommended to develop stronger links to tsunami early warning system and with a view to develop multi-hazard early warning system (MHEWS). A CIFI Guide is being drafted to provide Guidance to WMO Members on how to establish and implement a CIFI.

58. Ms Grimes also highlighted public awareness efforts in regards to coastal inundation to improve last mile response by the public to inundation alerts and she suggested this be an area for collaboration with the tsunami community.

59. Finally, Mr Honoré reported on the ongoing efforts to establish a framework for a Global Multi-Hazard Alert System and develop an implementation plan and pilot initiatives under the auspices of the new WMO Technical Commissions. Full background can be found in the eighteenth session of the World Meteorological Congress, [WMO Resolution 13 \(Cg-18\)](#).

3. REVIEW OF PROGRESS

3.1 STATUS OF IMPLEMENTATION OF DECISION IOC-XXX/8.2

60. Mr Thorkild Aarup reported briefly on Decisions adopted at the 30th IOC Assembly (June 2019) and highlighted responses to a few of the decision points.

61. In terms of the ICG/PTWS, it was noted that the South China Sea Tsunami Warning System did enter into full operation on 5 November 2019 and an [IOC Circular Letter 2777](#) was sent out to Member States announcing.

62. In terms of the ICG/CARIBE-EWS, Charles McCreery (PTWC) informed that staff continue to explore new techniques that would alert its duty staff to the arrival of potential tsunami signals on sea level gauges. However, it was noted that identifying a tsunami (or meteotsunami) signal is still posing a challenge as there are many false triggers that can falsely indicate an extreme sea level event.

63. In terms of TOWS-WG, an action had been established to “Reiterate the importance of collecting event data strictly in accordance with the International Tsunami Survey Team (ITST) protocols”, this was highlighted and emphasized at the [International Symposium on the Lessons Learnt from the 2018 Tsunamis in Palu and Sunda Strait](#) (26–28 September 2019, Jakarta, Indonesia). This symposium reported findings from the IOC coordinated International Tsunami Survey Team.

64. In terms of registering of National Tsunami Warning Centres (NTWCs) and Tsunami Warning Focal Points (TWFPs) as alerting authorities in the “WMO Alerting Authority Register”, David Thomas (WMO) informed that not much progress had been observed mainly for two reasons: (i) registration is cumbersome with respect to process and interface; and (ii) Tsunami Alerting Centres do not appear as a separate category in the catalogue. WMO is in process of improving the interface to the register data base. In the meantime, he encouraged alerting centres to contact him directly to facilitate inclusion.

65. In terms of advocacy of World Tsunami Awareness Day, Thorkild Aarup noted that ICGs have advocated WTAD and more and more nations are participating to this activity. This is further reported under item [2.2.1](#).

66. In terms of the PTWS Framework, that work is ongoing and is reported by the Task Team on Disaster Management and Preparedness in [Annex III](#).

67. In terms of progress on non seismic tsunamis, that work is reported by the Task Team on Tsunami Watch Operations in [Annex IV](#).

68. In terms of engagement and advocacy in regards to the UN Decade of Ocean Science for Sustainable Development, Thorkild Aarup highlighted the activities the tsunami community had undertaken: (i) a community paper had been developed for OceanObs'19 outlining development steps for the transformational enhancement of the Global Tsunami Warning System (Angove et al., 2019)²; (ii) a four-page flyer had been developed titled *Tsunami Taking on the Ocean's most dangerous waves*; (iii) direct input to implementation plan development titled "Protecting Communities from the World's Most Dangerous Waves"; (iv) participation at 1st Global Planning Meeting (Copenhagen, 13–15 May 2019) and several regional Decade workshops in 2019–2020. He also highlighted the upcoming Decade events notably at the UN Ocean Conference (Lisbon, 2–6 June 2020³) and the Decade kick-off meeting in Berlin (May/June 2021).

4. REPORTS OF THE INTER-ICG TASK TEAMS

4.1 INTER-ICG TASK TEAM ON DISASTER MANAGEMENT AND PREPAREDNESS

69. Ms Harkunti Pertiwi Rahayu reported on the outcome of the Inter-ICG Task Team on Disaster Management and Preparedness which met on 19 and 20 February 2019 in Paris. The full summary of the Task Team meeting and its recommendations are provided in [Annex III](#) of this report.

4.2 INTER-ICG TASK TEAM ON TSUNAMI WATCH OPERATIONS

70. Mr Charles McCreery reported on the outcome of the Inter-ICG Task Team on Tsunami Watch Operations which met on 18 and 19 February 2020 in Paris. The full summary of the Task Team meeting and its recommendations are provided in [Annex IV](#) of this report.

5. UN DECADE OF OCEAN SCIENCE FOR SUSTAINABLE DEVELOPMENT

71. Mr Julian Barbière, Head of the IOC Marine Policy and Regional Coordination Section and focal point for the Decade, reported on this item.

72. In 2016, IOC Member States started a discussion and global initiative on how to strengthen support of science to achieve sustainable development and in support of solutions. It was realized that such an initiative would go beyond the IOC as many disciplines and policy areas have an ocean dimension. This effort developed into the proposal for a UN Decade of Ocean Science for Sustainable Development. That gathered steam and was first adopted by the IOC Assembly and subsequently adopted by the UN General Assembly (UNGA) in early December 2017. As a result of that effort, IOC was tasked by the UNGA to coordinate the development of an implementation plan for the Decade.

73. This effort first started with developing a vision for the Decade and a Roadmap document which the IOC Executive Council adopted in 2018. It established a process for the development of the draft Implementation Plan and have tasked an Expert Planning Group to guide the development of the plan.

² Angove et al. 2019. Ocean Observations Required to Minimize Uncertainty in Global Tsunami Forecasts, Warnings, and Emergency Response. *Frontiers in Marine Science*. (<https://doi.org/10.3389/fmars.2019.00350>)

³ By the time of publication, the 2020 UN Ocean Conference was postponed to a later date due to the Covid-19 pandemic. (This was officially announced on 14 April 2020.)

74. The Decade planning has high focus on societal benefits and outcomes. These outcomes are considered to be highly transformative because they are expected to trigger environmental, societal and policy changes. So far, the planning process has converged towards six broad societal outcomes that are: (i) a clean ocean; (ii) a healthy and resilient ocean; (iii) a predicted ocean; (iv) a safe ocean; (v) a sustainable productive ocean; and (vi) a transparent and accessible ocean.
75. These initial priority areas are interconnected but allow focused design and planning, and are expected to be able to garner broad contributions.
76. It is expected that the Decade and these outcomes will address both deep disciplinary understanding of ocean processes and solution-oriented research to generate knowledge. This knowledge will support societal actors in reducing pressures of the ocean, preserving and restoring ocean ecosystems and safeguarding ocean-related prosperity for generations to come. The Decade should turn the scientific knowledge and understanding into effective actions supporting improved ocean management, stewardship and sustainable development.
77. The zero draft of the Implementation Plan will be completed in March 2020. Mr Barbière emphasized that there has been considerable consultation with stakeholders during the planning process. This has included regional workshops and awareness raising events scientific meetings. Input from these activities have been incorporated in the plan.
78. Finally, Mr Barbière provided the time line for the completion of the Implementation Plan. The zero draft will be sent out by the end of March for extended review by the extended scientific community, NGOs and UN institutions. Subsequently, a revised version 1 will be sent out for review to IOC Member States in May with a view of formal adoption of a finalised plan by the 53rd IOC Executive Council. The plan will then be sent to the UN General Assembly for formal endorsement in the 4th quarter of 2020.
79. Mr Barbière informed that a call will be launched in March 2020 for large scale projects or flagship projects will be launched in March 2020 with a view to highlight and promote a set of these at the UN Ocean Conference in Lisbon (2–6 June 2020). Mr Barbière encouraged the tsunami community to consider this as an opportunity to develop a global initiative.
80. More information about the Decade and the planning process can be found in Ryabinin et al. (2019)⁴.

6. OTHER ISSUES

81. No other issues were reported.

7. DATE AND PLACE OF THE NEXT MEETING

82. The Chair and Technical Secretary will establish the date and place of the 14th meeting of TOWS-WG.

8. CLOSURE OF MEETING

83. Mr Thorkild Aarup informed that this would be his last meeting serving as Technical Secretary for TOWS-WG. He expressed his sincere thanks to the Chair and Group for

⁴ Ryabinin et al. 2019. The UN Decade of Ocean Science for Sustainable Development. *Frontiers in Marine Science*. (<https://www.frontiersin.org/articles/10.3389/fmars.2019.00470/full>)

collaboration over the years and wished the best of luck with the future developments of the Global Tsunami Warning System.

84. The Thirteenth meeting of TOWS-WG was closed at 12:30 on 21 February 2020.

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)
- 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 Thirteenth Meeting of the Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG-XIII) was held at UNESCO Headquarters in Paris, on 20–21 February 2020 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 Thirtieth session (26 June–4 July 2019, Paris).

The Group recognized there remains a fundamental capability gap when it comes to providing accurate, actionable tsunami forecasts to the most at-risk coastal communities. The Group has fully described this gap through a combination of peer-reviewed publications, conferences and consultations over the past two years.

The Group further recognized that the UN Decade of Ocean Science for Sustainable Development provides a once-in-a-generation opportunity to address and potentially fill this gap by leveraging novel sensing platforms, techniques and/or infrastructures in order to quickly detect and measure tsunamis the near-instant they form.

The Group requested that the IOC Executive Council at its session in 2020 strongly advocate for the inclusion of a flagship initiative under the UN Decade of Ocean Science aimed at addressing this glaring capability gap in global tsunami forecast and warning services.

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

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

- Two exercises carried out (CARIBE WAVE 2019 and PACWAVE 2019) and regular communication tests performed,
- Ongoing progress in sharing the results of Tsunami exercises and communication tests with World Meteorological Organization (WMO) and improvements in alert message delivery rates for IOTWMS,
- Several communities having achieved Tsunami Ready recognition including Omoa and Tornabe (both Honduras), Bluefields and Corn Island (both Nicaragua), and more than ten communities in process of seeking Tsunami Ready recognition,
- Instituto Português do Mar e da Atmosfera (IPMA) having been accredited as a Tsunami Service Provider in NEAMTWS,
- South China Sea Tsunami Advisory Center (SCSTAC) (hosted at National Marine Environmental Forecasting Center of P. R. China (SCSTAC/NMEFC)) having started full operation on 5 November 2019,
- Central American Tsunami Advisory Center (CATAC) (hosted at Nicaraguan Institute of Territorial Studies (INETER)) started trial operation in August 2019,
- the International Symposium on lessons learnt from the 2018 Tsunamis in Palu and Sunda Strait, Jakarta, Indonesia, 26–28 September 2019 (see [summary statement](#)),

- efforts by Indonesia to densify its national detection network in response to the Palu and Sunda Strait events,
- efforts to strengthen tsunami resilience in Makran area through UNESCAP funded project “Strengthening tsunami early warning in the North West Indian Ocean region through regional cooperation”.

The Group approved changes to the Area of Service Map ([Appendix 4](#) to Annex IV).

The Group recommended to the Executive Council at its session in 2020 to encourage Member States to:

- increase and sustain technical and financial support of the tsunami and other coastal hazards warning systems in their respective regions,
- emphasize to their national civil protection/disaster management agencies the role they play in strengthening the warning chain to ensure optimal community response; and stress the importance of the participation of their agencies in regional tsunami governance and technical forums,
- continue to strengthen tsunami awareness and preparedness in communities and among authorities through communication, evacuation planning, tsunami exercises, training, information, and piloting recognition programmes such as Tsunami Ready,
- densify sea-level networks capable of Tsunami detection as well as seismic network particularly nearby tsunamigenic sources,
- implement a sample rate of 1 sample/sec or higher on sea level gauges in order to record and transmit tsunami wave-form data from all seismic and non-seismic sources,
- recommend that Member State authorities and station operators share existing seismic, sea level, GNSS and other data types, including their meta-data, in real or near real-time with Tsunami Service Providers and National Tsunami Warning Centres for a more effective and comprehensive global tsunami early warning,
- 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 commissions,
- 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,
- request their National Tsunami Warning Centres to make public national tsunami warnings available in the Common Alerting Protocol (CAP) format as an addition to their current messages, as applicable. This would allow this warning information together with other coastal hazard warnings to be widely disseminated and available on multiple platforms such as the Global Meteo Alert System (GMAS) under development by World Meteorological Organization.

The Group recommended the Executive Council at its session in 2020 to instruct the regional Intergovernmental Coordinating Groups to:

- advocate World Tsunami Awareness Day (WTAD) 2020 among their Member States and highlight target [e] of the Sendai Framework to *Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020*;
- continue the Tsunami Ready pilot activities with UNESCO-IOC recognition, including conducting surveys on Member State status, interest and feedback in the implementation of Tsunami Ready;
- enhance participation of Civil Protection Agencies in their routine activities;
- discuss procedures and best practices for local source tsunami response based on the guidelines provided by the Pacific Tsunami Warning System and as revised by the Indian Ocean Tsunami Warning and Mitigation System (*Document in progress: [Local-Source Tsunami Response Best Practice](#), version 1*).

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 operation.

The Group further instructed the Inter-ICG task teams to review and propose updates to the Framework Document of the Ad Hoc Working Group for Global Tsunami and Other Ocean-Related Hazards Early Warning System (GOHWMS) ([IOC-XXIV/2 Annex 10](#)– also discussed at the 1st session of TOWS-WG (Paris, 3–4 April 2008).

The Group acknowledged United Nations Office for Disaster Risk Reduction (UNDRR) efforts to develop training with regional broadcast unions (RBU) on disaster risk reduction including tsunamis.

The Group recommended the Executive Council at its session in 2020 to 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].

The Group expressed appreciation to Japan Meteorological Agency and the Northwest Pacific Tsunami Advisory Center (NWPTAC) for having provided interim service for the South China Sea from 2006 until the start of full operation of SCSTAC on 5 November 2019.

The Group noted with appreciation the information presented by WMO on its organizational changes and the newly established WMO-IOC Joint Collaborative Board.

ANNEX III

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

18–19 February 2020
Paris, France

Task Team Members

Harkunti Pertiwi Rahayu	ICG/IOTWMS (Chair a.i.)
Ardito Kodijat	IOTIC, ICG/IOTWMS
Laura Kong	ITIC; ICG/PTWS
Marzia Santini	ICG/NEAMTWS
Amir Yahav	ICG/NEAMTWS
Christa von Hillebrandt-Andrade	ICG/CARIBE-EWS ICG/CARIBE-EWS
Alison Brome	CTIC; ICG/CARIBE-EWS
Bernardo Aliaga	IOC Secretariat
Denis Chang Seng	IOC Secretariat; TIC/NEAMTWS
Luis Aguilar	IOC Secretariat, Intern
Irina Rafliana	Observer
Silvia Chacon Barrantes	Observer

BACKGROUND AND TERMS OF REFERENCE

The Terms of Reference (TORs) of the Inter-ICG Task Team on Disaster Management and Preparedness (TT-DMP) are to:

- Facilitate in collaboration with organization such as UNISDR (United Nations Office for Disaster Risk Reduction), the exchange of experiences and information on preparedness actions, education/awareness raising campaigns and other matters related to disaster management and preparedness;
- Promote preparedness in coastal communities through education and awareness products and campaigns;
- Facilitate SOP training across ICGs to strengthen emergency response capabilities of Member States and their Disaster Management Offices;
- Promote preparedness programs and assessment tools that have been successful in one regional Tsunami Warning and Mitigation System in the others as appropriate;
- Facilitate the coordination of the TICs of the ICGs;
- Report to the TOWS–WG.

The representatives to the TT-DMP are nominated by their respective Chairpersons of the Intergovernmental Coordination Groups (ICGs). The membership consists of two representatives from each ICG, one of which should represent the ICG's Tsunami Information Center. The IOC Chair appoints the Chair of the Task Team.

The first meeting of the TT-DMP was held in December 2010 in Seattle, USA (IOC/TOWS-WG/TT2-I/3). Due to funding limitations the task team was unable to reconvene in the period up to February 2014 when it met in Paris, France (IOC/TOWS-WG/TT2-II). Since then the TT-DMP managed to meet annually: March 2015 in Morioka, Japan, and in Paris in February 2016, 2017, 2018, 2019 and 2020 prior to the annual meetings of the IOC/TOWS-WG. This report covers the period 2019–2020.

TASK TEAM MEETING

1. OPENING AND MEETING ORGANIZATION

The Chair (a.i.) introduced the meeting logistics and asked self-introductions of the participants.

2. REFLECTION ON TT REPORT TO TOWS-WG-XII (2019)

The meeting worked through the previous TT Report to TOWS and confirmed that the meeting agenda reflects the points to be followed up from that report.

The meeting reflected on the recommendations and action points taken in 2019. It noted that most of the action points will be discussed under the 2020 agenda (this meeting).

With regards to the recommendation that requests the ICGs to coordinate on 'Wave exercise' dates in order to minimize overlap, the meeting discussed the possibility to align exercise dates across ICGs. This was considered not practical across all ICGs because of different hazard seasons (i.e. cyclones). For the Indian Ocean and Pacific Ocean, the TT agreed that a better coordination is possible.

The Task Team noted that the ICGs are coordinating Wave' exercises questionnaires and applying online tools.

The Task Team received a report of the International Symposium on the Lessons Learnt from the 2018 Tsunamis in Palu and Sunda Strait, 26–28 September 2019, Jakarta, Indonesia, hosted by the Government of Indonesia.

Recommendations to TOWS-WG:

Recommends that ICGs coordinate Exercises and in particular that PTWS and IOTWMS Wave Task Teams coordinate themselves to suggest alternate odd/even years to avoid overlap;

Notes that ICGs are coordinating Wave' exercises questionnaires and applying online tools;

Recommends to convene a workshop on WAVE exercises before the TOWS task meeting in 2021;

Notes that IOTWMS successfully organized the International Symposium on the Lessons Learnt from the 2018 Tsunamis in Palu and Sunda Strait, 26–28 September 2019, Jakarta, Indonesia, hosted by the Government of Indonesia.

3. REPORTS FROM ICG WG & TIC REPRESENTATIVES

The Task Team collected updates on Disaster Management and Preparedness and Tsunami Information Centre activities across ocean basins over the last year. This information reflects the progress and identification of collective relevant issues to be addressed at global level. The reports are posted on the meeting calendar web-page and due to their size are not included in this report. The presentations can be found on the Meeting page in the IOC Tsunami Programme Calendar.

The Task Team noted the good progress made across ICGs and TICs and noted European Commission's support to the tsunami risk management in the NEAM region, in particular towards last mile tsunami warning and preparedness, through the Tsunami Last Mile project.

Recommendation to TOWS-WG:

Notes the European Commission support to the tsunami risk management in the NEAM region, in particular towards last mile tsunami warning and preparedness, through the Tsunami Last Mile project, funded by DG ECHO and coordinated by the Joint Research Centre (JRC) of the European Commission, successfully implemented in two NEAMTWS Member States; and **invites** the IOC Secretariat to explore with JRC potential for joint initiatives.

4. SIGNIFICANT OPERATIONAL EVENTS SINCE LAST MEETING

The Task Team, jointly with the Task Team on Tsunami Watch Operations, reflected on tsunami events over the last year, in particular atypical events in the Atlantic ridge and Puerto Rico. Presentations were made by representatives from IOTWMS, PTWS/CARIBE EWS and NEAMTWS.

5. TSUNAMI GLOSSARY UPDATE

No updates on the Tsunami Glossary were presented to the Task Teams.

6. DEVELOPMENT OF KEY PERFORMANCE INDICATORS IN RELATION WITH SENDAI FRAMEWORK INDICATORS

Recommendation to TOWS-WG:

Recommends the Team comprising Sarah-Jayne McCurrach (PTWS), Yuelong Miao and Harkunti Rahayu (IOTWMS), Elizabeth Vanacore and Mary Rengifo (CARIBE-EWS), and Öcal 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.

7. LOCAL SOURCE TSUNAMI SOPs

The Task Team, jointly with the Task Team on Tsunami Watch Operations heard a presentation by Dr Ken Gledhill (PTWS) about the development of guidelines for NTWCs with regards to local source tsunamis and IOTWMS reporting Task Team on this same subject.

Recommendation to TOWS-WG:

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.

8. NATIONAL TSUNAMI WARNING CENTRE COMPETENCY FRAMEWORK

The Task Team, jointly with the Task Team on Tsunami Watch Operations, heard a presentation by Dr Ken Gledhill about the development of a competency framework for NTWCs. The Secretariat reported on a newly approved project for the Ocean Teacher Global Academy (OTGA 2.0) 2020–2023, funded by the Government of Flanders.

The Task Teams noted the piloting of the NTWC competency framework training in Tonga, in cooperation with ITIC.

Recommendations to TOWS-WG:

Notes the approval of the OTGA 2.0 project by the Government of Flanders and the inclusion of five potential tsunami courses under the OTGA platform; and

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

9. PLANNING FOR OCEAN DECADE

The Task Team, jointly with the Task Team on Tsunami Watch Operations, heard a presentation by Adrienne Moseley (Australia) on a proposed statement for the Ocean Science Decade for Sustainable Development suggested by IOTWMS focused on data sharing and a presentation of Laura Kong (ITIC) on the SMART cable systems (Science Monitoring And Reliable Telecommunications) and its relation to several global frameworks including the Ocean Science Decade for Sustainable Development.

10. UNESCO/IOC TSUNAMI READY (UNESCO/IOC TR) PILOT PROGRAMMES

The Task Team received a report of the Workshop on Tsunami Ready pilot programme – procedures, documentation, and operation experiences, 17 February 2020, Paris, France. During the workshop Indonesia presented remotely its ISO Community Based Early Warning Systems initiative.

Recommendations to TOWS-WG:

Recommends that the draft Tsunami Ready Guidelines (MG-74) to include guidance about resource needs, with input from Tsunami Information Centres;

Agrees that the Inter ICG Task Team on Disaster Management and Preparedness to discuss and endorse the draft guideline before it goes to ICGs, to be ready by the end of May 2020;

Recommends Indonesia to present its ISO Community Based Early Warning Systems initiative to the Inter ICG Task Teams at its next session in 2021;

Notes that the Secretariat has provided two options for a Draft Tsunami Ready logo, recommends to accept both leaving its finalization and guidance for usage to UNESCO/IOC Secretariat;

Notes that UNESCAP, USAID/OFDA, DIPECHO and corresponding national, regional and local authorities have continued to provide funding support to Tsunami Ready pilot and **invites** contributions from other agencies.

11. TSUNAMI EVACUATION MAPPING – IOC Manuals & Guides, 82

The Tsunami Evacuation Mapping Planning and Procedures (TEMPP) Guideline has been finalised.

Recommendation to TOWS-WG:

Notes the publication of *Preparing for community tsunami evacuations: from inundation to evacuation maps, response plans and exercises* ([IOC/2020/MG/82](#)).

12. TSUNAMI GUIDANCE FOR MARITIME AND PORTS – DEVELOPMENT OF GUIDELINES

Dr Laura Kong (ITIC) reminded that at the last session the ITIC requested translation of best practices documented by Japan. The PTWS has requested the ITIC to compile best practices for sharing on the ITIC website.

Recommendation to TOWS-WG:

Recommends that TOWS-WG formally request Japan to provide an English version of the Tsunami Maritime and Ports Guidance document.

13. STRUCTURAL DESIGN GUIDANCE FOR BUILDINGS THAT CAN BE USED AS EVACUATION SHELTERS

Recommendations to TOWS-WG:

Notes that US FEMA has published its third version of the Guidelines for Design of Structures for Vertical Evacuation from Tsunamis ([FEMA P-646 / August 2019](#));

Notes that the compilation of best practices for sharing on the ITIC website is a pending task and **requests** ICGs to ask Member States to send ITIC best practices and/or guidelines on structures that can be used for vertical evacuation.

14. SCHOOLS PROGRAMMES

The meeting recalled the involvement of IOTIC and ITIC in UNDP School Drill Project Phase 1. There are no further follow up from UNDP and TICs on the implementation of the School Drill Phase 2 with the understanding UNDP is implementing the project at national level.

The initiatives at different basins in strengthening the capacities of schools to respond to tsunami threat through the tsunami warning system have been proliferated. Nevertheless, there are still issues on sustainability, and sense of dependencies of communities and schools.

Recommendations to TOWS-WG:

Notes that there are number of programs facilitated by UN organizations, such as School Safety Program of UNESCO, UNDRR, UNDP and others;

Notes that there is a number of publications on school disaster preparedness and disaster risk reduction curricula published by UNESCO Education Sector as well as the Geo-hazard of UNESCO Science Sector;

Recommends IOTIC to compile the list of school disaster risk reduction and preparedness materials and make it available for the next meeting.

15. WORLD TSUNAMI AWARENESS DAY (WTAD) 2020

Recommendations to TOWS:

Encourages ICGs to recommend to member states to observe WTAD 2020 by putting special emphasis on local tsunami risk reduction strategies, including Tsunami Ready programme;

Recommends that UNDRR is invited to attend on a regular basis the Task Team on Disaster Management and Preparedness meetings, for proper coordination of future WTAD celebrations.

16. PRESENTATION: ISRAEL EARTHQUAKE & TSUNAMI EXERCISE 2019

Amir Yahav reported that on 12th March 2019 Israel executed an end to end national tsunami exercise. The exercise combined several exercises:

- International Tsunami alert system exercise
- International TSP's exercise
- Seismology exercise
- Decision makers exercise
- National police exercise + helicopters and drones
- Home front command exercise – loud speakers alerting the public
- 18 schools tsunami exercises – 8 schools evacuation exercises (7000 students)
- 8 local authorities exercises – measures taken with the evacuated population

The exercise's goal was to improve the home front's preparedness for tsunami, emphasizing on saving lives by effective reaction to tsunami alert. The scenario for this exercise included:

- A remote 7.4 m earthquake, west to Cyprus, causing Tsunami
- about 30 minutes alert (potentially)
- inland flooding height – 1-2 m

The exercise supported Tsunami related activities:

- National Table top exercise – Tsunami preparedness
- Decisions Makers – orientation day
- International seminar – Tsunami preparedness
- Professional field trips
- Hosting a Tsunami preparedness delegation of international experts

Mr Yahav expressed thanks to NEAMTWS TSPs: KOERI (Turkey) and NOAA (Greece) for their kind agreement to assist Israel with our tsunami exercise and acknowledged UNDRR – public relations and communication team for their kind agreement to cover the international tsunami exercise.

17. SUMMARY OF RECOMMENDATIONS TO THE TOWS-WG-XIII

The Task Team recommends that the TOWS-WG-XIII:

Recommends that ICGs coordinate Exercises and in particular that PTWS and IOTWMS Wave Task Teams coordinate themselves to suggest alternate odd/even years to avoid overlap;

Notes that ICGs are coordinating Wave' exercises questionnaires and applying online tools;

Recommends to convene a workshop on WAVE exercises before the TOWS task meeting in 2021;

Notes that IOTWMS successfully organized the International Symposium on the Lessons Learnt from the 2018 Tsunamis in Palu and Sunda Strait, 26–28 September 2019, Jakarta, Indonesia, hosted by the Government of Indonesia;

Notes the European Commission support to the tsunami risk management in the NEAM region, in particular towards last mile tsunami warning and preparedness, through the Tsunami Last Mile project, funded by DG ECHO and coordinated by the Joint Research Centre (JRC) of the European Commission, successfully implemented in two NEAMTWS Member States; and **invites** the IOC Secretariat to explore with JRC potential for joint initiatives;

Recommends the Team comprising Sarah-Jayne McCurrach (PTWS), Yuelong Miao and Harkunti Rahayu (IOTWMS), Elizabeth Vanacore and Mary Rengifo (CARIBE-EWS), and Öcal 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;

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;

Notes the approval of the OTGA 2.0 project by the Government of Flanders and the inclusion of five potential tsunami courses under the OTGA platform; and

Recommends to use the National Tsunami Warning Centre Competency Framework in designing online and onsite training courses planned under the Ocean Teacher Global Academy (OTGA) project;

Recommends that the draft Tsunami Ready Guidelines (MG/74) includes guidance about resource needs, with input from Tsunami Information Centres;

Agrees that the Inter ICG Task Team on Disaster Management and Preparedness to discuss and endorse the draft guideline before it goes to ICGs, by the end of May 2020;

Recommends Indonesia to present its ISO Community Based Early Warning Systems initiative to the Inter ICG Task Teams at its next session in 2021;

Noting that the Secretariat has provided two options for a Draft Tsunami Ready logo, **recommends** to accept both leaving its finalization and guidance for usage to UNESCO/IOC Secretariat;

Notes that UNESCAP, USAID/OFDA, DIPECHO and corresponding national, regional and local authorities have continued to provide funding support to Tsunami Ready pilot and **invites** contributions from other agencies;

Notes the publication of *Preparing for community tsunami evacuations: from inundation to evacuation maps, response plans, and exercises* ([IOC/2020/MG/82](#));

Recommends that TOWS-WG formally request Japan to provide an English version of the Tsunami Maritime and Ports Guidance document;

Notes that US FEMA has published its third version of the Guidelines for Design of Structures for Vertical Evacuation from Tsunamis ([FEMA P-646 / August 2019](#));

Notes that the compilation of best practices for sharing on the ITIC web site is a pending task and **requests** ICGs to ask Member States to send ITIC best practices and/or guidelines on structures that can be used for vertical evacuation;

Notes that there are number of programs facilitated by UN organizations, such as School Safety Program of UNESCO, UNDRR, UNDP and others;

Notes that there is a number of publications on school disaster preparedness and disaster risk reduction curricula published by UNESCO Education Sector as well as the Geo-hazard of UNESCO Science Sector;

Recommends IOTIC to compile the list of school disaster risk reduction and preparedness materials and make it available for the next meeting;

Encourage ICGs to recommend to member states to observe WTAD 2020 by putting special emphasis on local tsunami risk reduction strategies, including Tsunami Ready programme;

Recommends that UNDRR is invited to attend on a regular basis the Task Team on Disaster Management and Preparedness meetings, for proper coordination of future WTAD celebrations; and

Extend the tenure of the Task Team on Disaster Management and Preparedness for a further term with the same Terms of Reference.

ANNEX IV

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

18–19 February 2020, Paris

1. OPENING AND MEETING ORGANIZATION

Dr Charles (Chip) McCreery, the Chair of the Task Team on Tsunami Watch Operations (TTTWO), welcomed all participants to the meeting (refer to list of participants in [Annex V](#)). He introduced the provisional meeting agenda, which was adopted without any modifications (refer to [Appendix 1](#)).

2. REVIEW OF ACTION ITEMS FROM THE PREVIOUS MEETING

REVIEW OF ACTIONS

Dr McCreery reviewed the outstanding recommendations and actions from the TTTWO meeting held in Paris, France, 14–15 February 2018 (ref: Summary Report, [TOWS-WG, Eleventh Meeting](#), Annex IV, Section 13.2, page 33) and 19–20 February 2019 (ref: Summary Report, [TOWS-WG, Twelfth Meeting](#), Annex IV, Section 16.2, page 13). The status of actions is listed below:

Action Item	Status
2018 Action 1: Dr Yuelong Miao to share a write up with the Task Team on methods to improve travel time estimates in tsunami bulletins and maps	Done.
2018 Action 2: IOTWMS to share with the Task Team, procedures for TSPs to handle inadvertent errors in issuing bulletins that are inconsistent with the agreed service definition.	Done.
2018 Action 3: CARIBE-EWS to share with the Task Team, procedures for TSPs to handle tsunamis from volcanoes.	Ongoing. To be further discussed under Agenda Item 16.
2018 Action 4: PTWC to provide guidance based on their experience with the W phase CMT and RIFT model on procedures to handle tsunamis generated from non-subduction earthquakes and mechanisms for sharing with the other ICGs	Ongoing.
2018 Action 5: Dr Yuelong Miao, Mr Carlos Zuniga Araya, Mr Patricio Carrasco and Dr Chip McCreery to help develop draft messages for vessels at sea for TSPs based on the template in IHO Manual S53 for WWNWS-SC to review and provide feedback	Done. To be further discussed under Agenda No. 13.
2018 Action 6: Dr Chip McCreery and Dr Francois Schindele to develop maps of the response of the current seismic and sea level network timing response for earthquakes and tsunamis for the four ICG regions based on the methodology accepted in the current Task Team meeting as examples of how to examine similar responses on a sub-regional level.	Done. To be further discussed under Agenda No. 15.
2019 Action 1: Appreciating the work of the PTWS Task Team on Future Goals and Performance Indicators, requests a team comprising Sarah Jane McCurrach, Yuelong Miao, Elizabeth Vanacore, Harkunti Rahayu and NEAMTWS representative/s to	Done. To be further discussed under Agenda Item 7.

Action Item	Status
review the PTWS performance monitoring framework in light of similar initiatives in other ICGs and recommend harmonised performance monitoring framework, data collection tools/questionnaire and reporting formats. The team will prepare a report for the next meeting.	
2019 Action 2: Recognising the Palu and Sunda Strait tsunami events as being very complex from an early warning perspective and further reiterating the increasing threat of tsunamis from near-source atypical sources (aerial landslides, submarine landslides, volcanoes), requests a team comprising Satoshi Harada, Francois Schindele, Weniza, Representative from Italy and Representative/(s) of TTDMP to explore current status and best practices for hazard assessment, monitoring and responding to tsunamis from atypical sources. The team will prepare a report for the next meeting.	Ongoing. To be further discussed under Agenda Item 12.
2019 Action 3: Mike Angove to report back to the group on feasibility of the implementation of operational warnings for meteorological tsunamis based on outcomes of the first world conference on meteotsunamis scheduled in Croatia during May 2019.	Ongoing. To be further discussed under Agenda Item 16.
2019 Action 4: Elizabeth Vanacore to report back to the group on procedures for handling of non-thrust tsunamigenic events from an operational warning perspective.	Ongoing. To be further discussed under Agenda Item 16.
2019 Action 5: Chip McCreery to develop maps of optimal seismic and sea-level networks for the ICG/IOTWMS and other regions in time for presentation to their upcoming ICG Sessions.	Done. To be further discussed under Agenda Item 15.
2019 Action 6: Francois Schindele and IOC Secretariat to incorporate updates to the Global Service Definition Document for consideration at the next meeting.	Ongoing. To be further discussed under Agenda Item 15.

3. REVIEW OF THE STATUS OF IMPLEMENTATION OF TOWS-WG REQUESTS TO TTTWO

Dr McCreery listed the recommendations made by TOWS-WG relevant to TTTWO during the last meeting held in Paris, France, 16–17 February 2018 (Summary Report, [TOWS-WG, Eleventh Meeting](#), Annex II, page 14) and 19–20 February 2019 (ref: Summary Report, [TOWS-WG, Twelfth Meeting](#), Annex II, page 3). The status of actions is listed below:

Action Item	Status
2018: to finalize sample tsunami threat messages for vessels at sea in consultation with the IHO/IMO/WMO World-Wide Navigational Warning Service Sub-Committee;	Done. To be further discussed under agenda item 13 .
2018: to continue efforts for monitoring and responding to tsunamis generated by non-seismic sources and possible integration into Tsunami watch operation;	Ongoing. To be further discussed under agenda item 12 .
2018: to consider the summary statement from the Symposium;	Ongoing.

<p>2018: to prepare concept note for developing capacity that can lead to transformative tsunami warning products that enable stakeholders to manage public response efficiently;</p>	<p>Done. To be further discussed under agenda item 10.</p>
<p>2018: to contribute to OceanObs'19 and the planning of the UN Decade of Ocean Science for Sustainable Development.</p>	<p>Ongoing. To be further discussed under agenda item 10.</p>
<p>2019: to continue efforts for monitoring and responding to tsunamis generated by non-seismic sources and possible integration into Tsunami watch operation;</p>	<p>Ongoing. To be further discussed under agenda item 10.</p>

4. TSUNAMI WATCH OPERATIONS – CURRENT STATUS AND PLANS

4.1 CARIBE-EWS

Dr Wilfried Strauch briefed on the developed Central American Tsunami Advisory Centre (CATAC) with cooperation from Japan. CATAC is currently able to assess seismic events and disseminate messages using Seiscomp. While a tsunami database has been developed, official tsunami advisories are still not being issued. CATAC issued bulletins on an experimental basis for the most recent M7.7 earthquake located between Jamaica and Cayman Islands. There is a plan to work with Disaster Management Agencies on utilising CATAC information for providing early warnings. Maintenance of the centre and seismic network have commitment from the Nicaraguan government. It is also planned to submit an additional funding proposal to Japan. Work is underway on procedures for handling atypical tsunamis. A tsunami exercise was conducted in 2019 for Central America in addition to a meeting in Guayaquil, Ecuador, which discussed the possibility of a big event that could affect countries of Central America.

4.2 IOTWMS

Mr Pattabhi Rama Rao briefed on the status of the Indian Ocean Tsunami Warning and Mitigation System (IOTWMS). There are three operational Tsunami Service Providers from Australia, India and Indonesia providing interoperable tsunami threat information to the National Tsunami Warning Centres (NTWCs), which in turn are responsible for provision of detailed tsunami threat information for their coastal regions. Tsunami detection, warning and dissemination has been strengthened with Tsunami Service Providers (TSPs) incorporating several technical enhancements in their procedures and products including launching of public websites by all TSPs. Routine communications tests were conducted in June and December 2019 with email emerging as the most successful means of communication followed by the Global Telecommunication System (GTS). Mr Pattabhi reported on the performance of the TSPs against the Key Performance Indicators (KPIs) and progress and plans of the 3 TSPs.

4.3 NEAMTWS

Dr Francois Schindele reported on recent developments in the North-Eastern Atlantic and Mediterranean Tsunami Early Warning and Mitigation System (NEAMTWS). Portuguese Institute of the Sea and the Atmosphere (IPMA) has now become operational. There are 5 TSPs in the NEAMTWS with at least 2 TSPs monitoring each sub basin. In the NEAMTWS region, there has been discussion on the possibility of harmonising alert levels in the TSP messages (information, advisory, watch and warning). In France, there is a colour scheme that is followed to indicate different threat levels along with action statements for authorities and public.

4.4 PTWS

Dr Chip McCreery provided an update on Pacific Tsunami Warning Center (PTWC) operations in support of Pacific Tsunami Warning and Mitigation System (PTWS) and the Tsunami and other Coastal Hazards Warning System for the Caribbean and Adjacent Regions (CARIBE-EWS). Mr Yuji Nishimae briefed that the Northwest Pacific Tsunami Advisory Center (NWPTAC) of the Japan Meteorological Agency (JMA) started issuing its new graphical products in support of the PTWS in February 2019. The South China Sea Tsunami Advisory Centre (SCSTAC) started operations for the South China Sea coastal areas in November 2019. NWPTAC ceased its interim advisories to the South China Sea at the start of SCSTAC services, but PTWC will continue.

This was followed by a brief discussion on how conflicting information from different warning centres for the same area of service should be handled by the National Tsunami Warning Centres (NTWCs) and/or Tsunami Warning Focal Points (TWFPs) of recipient Member States. Mr Mike Angove enquired whether CATAC information would conflict with information currently provided by PTWC for the CARIBE-EWS. Dr Strauch replied that CATAC information for events originating in the Central America region can be produced faster than that provided by the PTWC. It is considered better to provide initial warning for a worst-case scenario, and later step down warning if the event is smaller. Dr Ken Gledhill mentioned that this is an upcoming issue in the PTWS as well, since multiple warning centres have started providing information for the same area of service and that it will be useful to learn from experiences of other basins such as the Indian Ocean. Mr Yuji Nishimae mentioned that the same seismic parameters are shared among NWPTAC, SCSTAC and PTWC for issuing forecasts, and suggested that the highest wave estimates among centres be used for decision making by the Member States.

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 2](#).

5.1 CARIBE-EWS

Dr Elizabeth Vanacore briefed on the M 6.4 Puerto Rico earthquake of 7 January 2020 that was felt strongly, and was preceded and followed by a swarm of many small earthquakes. The event triggered a 4 cm tsunami. Even though only an Advisory (Marine Threat) was issued by local authorities, community evacuations were undertaken in several coastal areas after sirens were sounded by the disaster management. The disaster management authorities and the community could not differentiate between actions to be taken for a marine threat and land threat. There was also a discrepancy between the no-threat alert level issued by PTWC and the more conservative Marine Threat issued by local authorities that also added some confusion. Dr Vanacore mentioned that a survey of data reception methods by tsunami warning centres showed a dependency on emails and the internet, which unfortunately will be the first to fail during a near-source earthquake.

5.2 IOTWMS

Mr Pattabhi Rama Rao briefed on the 2 events in the inter-sessional period. For the M 6.4 earthquake off Broome, Australia, on 14 July 2019, all 3 TSPs issued earthquake information bulletins with a No Threat. This earthquake was equal to the largest earthquake ever recorded in the Australian region. There were reports of self-evacuation and water drawdown, though difficult to substantiate. No tsunami was observed from the closest Broome tide gauge. For the 2 August 2019 M 7.1 earthquake off Southwest of Sumatra, Indonesia, all 3 TSPs issued

earthquake information bulletins. Following this, TSP India issued a Potential Threat bulletin based on the model forecast of above threat threshold (0.5 m) waves for three Coastal Forecast Zones of Indonesia. Since there were no significant tsunami wave observations, TSP India issued a final bulletin.

5.3 NEAMTWS

Dr Francois Schindele briefed on the list of events in the NEAMTWS during 2018–2019. There were about 24 earthquakes in the North-East Atlantic between M 5.5 and 6.9 for which TSPs provided information in less than 15 minutes. Most of these events, being strike-slip and occurring close to the mid-Atlantic ridge, can be categorised as atypical events. In the Mediterranean, there were about 10 earthquakes between M 5.6 and 6.4. For the M 6.4 event in Albania, TSPs of Greece and Turkey provided Advisory messages within 5 minutes of the earthquake. No known tsunami was generated for any of the events. On 3 July 2019, Stromboli volcanic activity caused ash slides resulting in a tsunami that was recorded at Punto Labronzo and Punta dei Corvi. Further information can be found at <http://lgs.geo.unifi.it/index.php/blog/esplosione-parossistica-stromboli-3-luglio-2019>.

Dr McCreery enquired which magnitude scales are calculated for small earthquakes in the NEAM region. Dr Schindele clarified that MwP and Mw(B) are calculated. He further explained that there could be differences in initial and final magnitude estimates, however TSPs issue a revised bulletin only if the new magnitude estimate causes a change in tsunami threat levels.

5.4 PTWS

Dr Chip McCreery briefed on the response of PTWC for events in the Pacific and Caribbean. In the inter-sessional period, there were three significant earthquakes in the Pacific and one in the Caribbean. No damaging tsunamis were observed for any of these events. For the M 7.6 earthquake off Kermadec Island on 15 June 2019, a 14 cm tsunami was observed; for the M 7.3 earthquake in the Molucca Sea on 14 November 2019, an 11 cm tsunami was observed; and for the M 7.7 earthquake off Cuba on 28 January 2020, an 11 cm tsunami was observed. He reported that for the Cuba earthquake, both the old and new PTWC websites failed to show the PTWC products due to an issue with the IT certificates used to validate information passed to the website. He noted that the constant changes now required for maintaining the security of IT platforms and networks are also the inadvertent cause of many outages.

5.5 NEW ZEALAND DART NETWORK

Dr Ken Gledhill made a presentation on the Deep-ocean Assessment and Reporting of Tsunamis (DART) network being established by New Zealand. “Long or Strong, Get Gone” was advocated for tsunami preparedness in New Zealand for quite some time due to the near source nature of the threat. However, numerical simulations suggest that even a near-source M 8.5 may not be strongly felt in the western North Island. The only way to provide warnings to communities for such events is to detect tsunamis as soon as they are generated. DART buoys play a major role in providing such warnings. The New Zealand DART network is designed to detect tsunamis in 25–30 minutes. Four buoys have already been deployed with others planned to be deployed shortly. Data will be shared on the GTS and also via a redundant communication mode. Considering that, this network will substantially enhance tsunami warning capability in the PTWS, Dr Gledhill invited international cooperation with other Member States that are implementing DART networks such as Australia, Chile, the United States, etc. in establishing and maintaining the network.

During discussions that followed, Mr Carlos Zuniga Araya and Mr Patricio Carrasco emphasized that tsunami wave exercises generally simulate very large magnitude earthquakes that generate significant tsunamis. However, it is also important to exercise for

smaller events near the threshold magnitude for warnings and test the associated procedures and responses. Such events are more common than larger earthquakes. The Tsunami Coastal Assessment Tool (TSUCAT) can be a very useful tool for countries to exercise any magnitude that suits them.

6. TSUNAMI GLOSSARY UPDATE

No proposal for changes to the Tsunami Glossary ([IOC/2008/TS/85 Rev.4](#)) were received to date. It was agreed that any future updates may be discussed at the next TOWS-WG meeting in 2021.

7. DEVELOPMENT OF KPIS IN RELATION WITH SENDAI FRAMEWORK INDICATORS

Dr Harkunti Rahayu briefed on the Key Performance Indicator (KPI) framework in relation to Sendai Framework for Disaster Risk Reduction (SFDRR) indicators. At the last meeting, a team comprising Ms Sarah-Jayne McCurrach (PTWS), Dr Yuelong Miao and Dr Rahayu (IOTWMS), Dr Elizabeth Vanacore and Ms Mary Regifo (CARIBE-EWS), and Dr Öcal Necmioglu (NEAMTWS) was requested to complete work on a harmonised performance monitoring framework including data collection tools/questionnaire and reporting formats for presentation to this meeting. During the inter-sessional period, Dr Miao provided useful inputs on how the PTWS KPI framework document can be improved to come up with a harmonised framework for all ICGs. Dr Rahayu drew the attention of the meeting to these inputs located at: http://www.ioc-tsunami.org/index.php?option=com_oe&task=viewDocumentRecord&docID=26465. It was agreed that the same team will complete this work on a harmonised performance monitoring framework.

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

8. LOCAL SOURCE TSUNAMI STANDARD OPERATING PROCEDURES (SOPs)

Dr Ken Gledhill reminded that, at the last meeting of the TOWS-WG Task Teams, it was decided that the PTWS will continue work on the document on local source tsunami response best practices and share their guidance with the other ICGs at this meeting. He provided a brief overview of the document that was approved by the ICG/PTWS at its Twenty-eighth meeting held in Nicaragua in April 2019. This document was subsequently reviewed by the IOTWMS which provided some useful inputs attempting to broaden the scope of the document to address non-seismic sources and also proposing new text for some sections that were listed in the PTWS document for subsequent consideration such as inclusion of false alarms, NTWC capabilities, etc. As far as the PTWS is concerned, work on the document has been completed. It is now up to the TOWS-WG Task Teams to decide if there is a need to come up with harmonised global guidelines on the subject or leave it to the ICGs to continue further work on the document, as is the case with IOTWMS, and adapt it as deemed suitable for their regions.

Dr Schindelé mentioned that in addition to point number 3, that specifies public awareness and education, there is also a need to have information on awareness and education for authorities involved in tsunami warning and mitigation. Gaps in the legal/policy framework in several countries to handle tsunami warning and emergency response were highlighted which

will pose difficulties in implementing common guidelines for local source tsunami response. Dr Christa Von Hillebrandt Andrade mentioned that the term “unofficial” warning may not be appropriate, since information coming from sources other than authorised agencies should not be considered as a warning at all. It was expressed that the current PTWS guideline was more directed towards NTWCs and further detailing is needed for disaster managers.

Dr Laura Kong and Dr Gledhill clarified that the purpose of this document was to serve as guidance to Pacific Island Member States to respond to a local tsunami threat. Dr Angove mentioned that near source tsunamis impact countries in all ocean basins and currently TSPs cannot provide the most effective warnings for such local tsunami threats. Hence it is advisable to have guidelines that could be used by all basins. There was considerable discussion on what constitutes a near-field threat, since response actions will be completely different depending on whether the tsunami travel time is 10 minutes or 30 minutes. It was also felt that lessons learnt from events such as Palu and Sunda Strait could provide a good basis for streamlining the guidance document. Dr Tummala informed that the IOTWMS inputs to this document incorporated learnings from Palu and Sunda Strait events, and also its experience in implementation of the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) project to enhance preparedness of North West Indian Ocean countries to deal with a near-field tsunami threat in the Makran region.

Considering that the threat varies widely among different countries and for different ocean basins, Member States and ICGs should continually analyse, be aware and have proper guidelines for handling near field tsunami threats. The PTWS document and IOTWMS inputs may be used as the basis for further work on such guidelines by interested member states and other ICGs.

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.

9. NATIONAL TSUNAMI WARNING CENTRE (NTWC) COMPETENCY FRAMEWORK

Dr Ken Gledhill provided a background and reminded that an NTWC competency framework document has been developed for the PTWS Member States. A core set of competencies for warning centres to train their staff on tsunami warning operations was identified. There are two levels of competency training – basic and advanced, with topics relating to detection of earthquakes and tsunamis, threat levels, decision making, understanding the science background, etc. International Tsunami Information Center (ITIC) trainings on earlier occasions have covered several of these components. Upon invitation by Tonga, ITIC conducted a training during 14–24 October 2019 that used the competency framework document to design the training. The course participants were trained in analysis of mareograms, installation and use of tools such as TSUCAT, etc. Seven forecasters with meteorology backgrounds participated in the training and evaluated the course. A hands-on mode of training was found to be the most preferred. This training was replicated in Indonesia in January 2020. The PTWS Competency Framework document will be finalised by the next PTWS Steering Group meeting in 2020, after which it will be shared to the other ICGs.

Mr Bernardo Aliaga briefed about the Ocean Teach Global Academy (OTGA)-2 project and the various components of tsunami warning that have been included therein – Standard Operating Procedures (SOP), Tsunami Evacuation Maps, Plans and Procedures (TEMPP), Tsunami Awareness, Hazard & Risk Assessments, etc. Dr Thorkild Aarup mentioned about the trainings that IOC undertakes for the Harmful Algal Bloom (HAB) programme that use a combination of online and in-class sessions. Online sessions are used to prepare basic training for the detailed in-class session to be followed.

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)

10. PLANNING FOR OCEAN DECADE

10.1 IOTWMS COMMUNIQUE ON “OPEN ACCESS TO REAL-TIME, FIT-FOR-PURPOSE DATA FOR EFFECTIVE TSUNAMI DETECTION AND WARNING”

Dr Adrienne Moseley (Australia) presented a draft communique by the IOTWMS Steering Group on “open access to real-time, fit-for-purpose data for effective tsunami detection and warning” ([Appendix 3](#)). Tsunami Service Providers currently face limitations in the provision of accurate and timely tsunami warnings due to insufficient real-time, fit-for-purpose data from Seismic, GNSS and Sea-level networks. The IOTWMS Steering Group opined that impactful improvements in tsunami warning can be achieved if Member States and network operators can provide open access to such data from already existing stations. This is possible through strong political and institutional will. Going forward, the IOTWMS Steering Group will incorporate any suggestions from this group and finalise the communique for adoption by the ICG/IOTWMS.

Dr Thorkild Aarup further clarified that this communique started as an IOTWMS initiative due to issues of data sharing in the region, and is being presented here to seek broader views from other basins. This is intended to be a focussed call from IOTWMS TSPs to high-level policy makers for open access to real-time, fit-for-purpose data to enhance tsunami early warning, rather than a broad call for open sharing of all marine data. This communique also intends to show a way by which governments can contribute in the immediate-term to enhance tsunami warning, in addition to important longer-term initiatives being planned as part of the UN Ocean Decade.

Discussions focussed on the feasibility of using the UN Ocean Decade as a platform for broader promotion of this idea. It was recalled that all UN Decade initiatives should lead to transformative impact, and the initiative by the tsunami community on “Protecting Communities from the Most Dangerous Waves” is a right step in this direction: http://www.ioc-tsunami.org/index.php?option=com_oe&task=viewDocumentRecord&docID=26670. It was agreed that open access to real-time, fit-for-purpose data from all existing stations as well as new stations being planned as part of the UN Ocean Decade is important for enhancing tsunami detection and warning. It was suggested that the statement in the draft IOTWMS communique about investments for providing greater access to observations be qualified, since transformative enhancements in tsunami warning are possible only through sustained investments over a longer term.

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

10.2 SMART CABLES

Dr Laura Kong made a presentation on the concept of Science Monitoring And Reliable Telecommunications (SMART) subsea cables initiative and its capability to measure essential ocean variables including those which can assist with tsunami warning. Reference was made to existing initiatives such as S-NET, Dense Ocean floor Network System for Earthquakes and Tsunamis (DONET), Neptune, etc. While dedicated single purpose systems are very expensive, partnering with the telecom private sector can substantially lower costs. A

submarine telecom cable costing 40K USD per km can be enhanced with SMART repeater capability with an incremental cost of 4K USD per km. There are several wet demonstration initiatives being planned including the INGV Italy-Sicily project, the Portugal–Azores–Madeira ring, Indonesia, New Caledonia–Vanuatu, etc. Dr Angove mentioned that a significant effort is needed to transition from wet demos to operationalisation. It needs a lot of resources, but it is important to keep advocating the importance due to the transformative benefits in tsunami warning that SMART cables can offer. Mr Nishimae reminded that the operational maintenance costs of dedicated networks could be high and can be a burden on operational organizations. Fixing cables on the sea floor can also be a challenging task especially in near-source regions since large earthquakes can roll over the cables leading to contamination of data. It is also highly desirable that data from all SMART cable networks is openly shared, much like the data from DONET and SNET that is openly available to researchers and operational agencies. Dr Aarup reminded that there will be a side meeting on submarine cables in the upcoming UN Ocean conference in Portugal.

Dr Fernando Carrilho provided a detailed update on the Portugal-Azores-Madeira ring of submarine cables that are due for replacement in 2024. An expert working group recommended that the new cables be instrumented with geophysical and environmental sensors due to additional advantages for real-time tsunami and earthquake monitoring with marginal cost and wider coverage. The core project is expected to cost 150 million dollars and an increment of 15 million dollars for additional sensors. The ring is being built by Autoridade Nacional de Comunicações (ANACOM), which is the government telecom operator in Portugal. IPMA estimated a gain in earthquake detection time and enhancement in earthquake parameterisation (due to reduction of azimuthal gap) by the addition of 10 sensors. While no significant gain in detection time is expected for mainland earthquakes, significant improvements are expected in the quality of earthquake parameterisation. Substantial gain in tsunami detection and warning time ranging from 10 to 30 minutes is expected for different coastal areas. There has been some reluctance from the telecom private players due to concerns regarding reliability of new instrumentation and how they might affect core cable operations or durability.

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

Dr McCreery initiated the discussion by displaying the current map of the Area of Service. The fact that none of the current TSPs cover the coastal regions of countries bordering the South Atlantic was discussed. This was identified to be a gap area considering the possibility of tsunamis that could result from atypical sources in this region. Some changes were agreed for the PTWS and NEAMTWS regions as follows. The revised AoS map is attached as [Appendix 4](#).

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

PTWS: Include AoS of the South China Sea Tsunami Advisory Centre (SCSTAC) in line with recommendations of the ICG/PTWS XVIII, noting that NWPTAC no longer provides service for this area.

NEAMTWS: Status of IPMA to be modified from Candidate TSP to Accredited TSP.

12. HARMONISATION OF FORMAT AND CONTENT OF TSP OPERATIONAL PRODUCTS ACROSS ICGS AND THE TSPS

Dr McCreery briefed on the general procedures that TSPs follow and the products that they issue. He noted that harmonisation of products across all TSPs would be a large and difficult task given the unique requirements of each AoS and the changes to software, documents,

training, etc. that would be needed. At the last SCSTAC Working Group meeting, Singapore raised the issue of bulletins between TSPs of IOTWMS and PTWS being different. The presentation was joined remotely by Mr Chan from Hong Kong who suggested that if all the TSPs can produce bulletins in Common Alerting Protocol (CAP) format, then it could be easier to compare similar information produced by different TSPs. Australia developed a special XML format for tsunami bulletins that PTWS is using. Discussion followed on whether all descriptors in standard CAP format are sufficient to provide tsunami warning information and if CAP formats are compatible with GTS. It was noted that CAP has been extensively used in the meteorology community as part of Global Multi-Hazard Alert System (GMAS). The National Oceanic and Atmospheric Administration (NOAA) has been using CAP to generate tsunami advisory products and they have developed formats to handle tsunami information. IOTWMS has also been working on CAP formats for handling tsunami warning in the Indian Ocean and is requested to provide an update on the progress of implementation at the next 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.

13. PRODUCTS FOR THE MARITIME COMMUNITY

Dr McCreery reminded that the proposal on TSP Messages for the Maritime Community was approved at the last meeting of the TOWS-WG, which requested the ICGs to consider implementation in their respective basins. Further, IOC Secretariat shared the final proposal with the Sub-Committee on the World-Wide Navigational Warning Service (WWNWS-SC) and is coordinating between ICGs and the WWNWS-SC for operationalising the service. Mr Pattabhi informed that IOTWMS TSPs started working on the service during the inter-session period under the guidance of WG-2, and will be ready with products by June 2020. The workshop on strengthening tsunami warning chain to critical infrastructure organised by the IOTWMS in Jakarta during November 2019 was used as an opportunity to brief representatives of ports/harbours and coastal airports on tsunami products. Though TSP maritime products will be issued only to the Navigational Area (NAVAREA; within the World Wide Navigational Service) coordinators, it is important to build capacities of representatives of ports/harbours, which will receive warnings from the NAVAREA coordinators.

14. GLOBAL PUBLIC ACCESS TO TSUNAMI THREAT INFORMATION

Dr McCreery reminded the Task Team that the original intention of this agenda was to explore the possibility of developing an integrated webpage/portal under the IOC/UNESCO tsunami programme which could have links to, or source information from all the ICG TSPs/NTWCs to provide the public with authoritative and up-to-date links tsunami warnings in different ocean basins. As a starting point, the TTTWO and the TOWS-WG approved a statement that could be displayed by the ICG TSPs on their public warning pages, acknowledging that their services are being provided under the IOC/UNESCO framework. All 3 IOTWMS TSPs have displayed the common statement on their websites. PTWC has not put it on their website yet pending a redesign of the site. The NWPTAC website statement is difficult to access directly since the link is deep within the JMA website. NEAMTWS TSPs currently do not have public websites, several of which are currently under preparation. Further discussion focussed on the benefit of having the websites of all TSPs and important TOWS-WG documents displayed on the [IOC Tsunami website](#). Dr Aarup mentioned that IOC Tsunami (IOC TSU) Programme webpages already list important documents and for a more standard archival, they are available via the UNESCO Digital Library ([UNESDOC](#)).

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.

15. OTHER ISSUES

15.1 OPTIMAL DESIGN OF SEA-LEVEL NETWORKS AND QC OF DATA FOR TSUNAMI WARNING

Dr McCreery reminded that NOAA has produced response maps of seismic and sea level stations for all ocean basins. It is now up to each ICG to decide if they would like to develop more detailed maps. Dr Tummala mentioned that IOTWMS decided not to develop more detailed maps, but use those produced by the PTWS noting the assumptions made in generating those maps. IOTWMS also decided to mount more active efforts to promote open data sharing from all existing stations to enhance tsunami warning. It was in this backdrop that a communique on open data sharing was prepared by the IOTWMS Steering Group (Ref. agenda item 10.1).

Dr McCreery highlighted the importance of quality assurance of sea-level data for tsunami early warning due to the recent experience with data from the Cayman Island tide gauge. The radar and pressure sensors were both operating for that gauge, but data from pressure sensor was significantly noisier, masking the tsunami, and one sensor was transmitted with the wrong units causing measurements to be incorrect. Dr Schindele highlighted that tsunamis generated by atypical sources such as landslides, volcanoes, and strike-slip earthquakes have very short periods (1–2 minutes). Unless sea level gauges have a much higher sampling frequency than the typical rate of one sample per minute, it is not possible to accurately record such waves. For monitoring tsunami waves from such sources, near-field (< 100 km) sea level gauge sampling should be at least 1 sample per second sampling and far field (> 100 km) gauges should have at least 4 samples per minute.

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.

15.2 UPDATES TO THE GLOBAL SERVICE DEFINITION DOCUMENT (GSDD)

Dr Francois Schindele highlighted the changes incorporated in section 4.7 (models), 4.8 (standard operating procedures), etc. of the *Tsunami watch operations: global service definition document* (GSDD) (IOC/2016/TS/130 REV.). 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 NTCs should take into careful consideration the status in different ICGs. It was decided that the modifications will be undertaken in the next inter-sessional period and put up for approval by the next meeting.

Action 5: Dr Francois Schindele and IOC Secretariat to finalise changes to the Global Service Definition Document for consideration at the next meeting.

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

16.1 JMA'S TSUNAMI WARNING OPERATION FOR NON-SEISMIC EVENTS

Mr Yuji Nishimae provided an overview of the JMA tsunami forecast system for seismic events that uses a database of 100,000 scenarios for providing an initial tsunami warning in 3 minutes.

Sea level monitoring network in Japan is comprised of tide gauges (174), Global Positioning System (GPS) buoys (8) and sea floor pressure sensors (214) which are operated by JMA and other organizations. Japan has 111 active volcanoes, some of which are marine volcanoes. JMA is responsible for monitoring active volcanoes as well as tsunamis. GPS and seismometers are used for volcano monitoring in addition to meteorological satellite data for monitoring volcanic ash clouds. The Raikoke volcano eruption in the Kuril Islands was monitored by JMA on 22 June 2019 and led to preparation of a preliminary standard operating procedure for a tsunami triggered by volcano collapse. Tsunami arrival times and heights at the coast can be estimated in advance using numerical simulations for a volcano generated avalanche. For coastlines near an island/marine volcano with a certain activity level, if an earthquake occurs near that volcano or a volcano avalanche is detected by cameras and/or nearby tide gauges record a tsunami, JMA will issue a prefixed tsunami warning and/or advisory as soon as possible.

Japan's Meteorological Research Institute investigated the detectability of submarine landslide by seismic records using data from the 1998 Papua New Guinea event. A tsunami of 10–15 m arrived at 6:09 pm local time on 17 July 1998, 20 minutes after the earthquake. The tsunami arrival was delayed and upon mapping the topography and analysis of hydrophone data, it was found that a landslide that occurred 10 minutes after the earthquake would have triggered the tsunami. There was no detectable seismic signal caused by the landslide at the expected arrival time of seismic wave on the seismogram. The only feasible solution to monitor for such a submarine landslide-triggered tsunami is by continuous monitoring of offshore sea level gauges (tsunameters).

In summary, offshore tsunameters are useful for early detection of tsunamis from atypical sources. Strong and close collaboration with the volcano observation authority is essential for early tsunami warning caused by the explosion and collapse of a volcano. The public should be made aware that tsunami generation can be caused by landslide, explosion and collapse of a volcano as well as by large earthquakes. Detection of generation of a submarine landslide is very difficult by seismic records after an earthquake because the seismic signals generated by a landslide are too small in comparison with seismic waves from the preceding earthquake and the landslide signals get masked. Sea level changes need to be continuously monitored by offshore tsunameters and coastal tide gauges and if larger than expected tsunamis are observed, tsunami warnings/advisory should be upgraded rapidly.

16.2 HAZARD AND WARNING FOR CRUSTAL EARTHQUAKES AND NON-SEISMIC TSUNAMIS IN ITALY

Dr Jacopo Selva, Italy National Institute of Geophysics and Volcanology (INGV), provided an overview of the initiatives in Italy and broader NEAM region on the hazard and warning for crustal earthquakes and non-seismic tsunamis. Most earthquakes in the NEAM region are atypical since they are crustal earthquakes (non-subduction). As part of the Probabilistic Tsunami Hazard Maps for the NEAM region (TSUMAPS NEAM) initiative, 10 million individual scenarios have been modelled for tsunami hazard in the Mediterranean. This was an input to Probabilistic Tsunami Hazard Assessment (PTHA) in the Mediterranean, and was used for setting up evacuation zones in Italy to cover maximum events with a return period of 2 500 years. The present day warning system for crustal earthquake generated tsunamis at INGV uses a decision matrix based on the epicentre location and magnitude. To overcome the drawbacks of this procedure in a small basin such as the Mediterranean, ongoing work is focussed on probabilistic methods for tsunami warning based on tsunami model database of crustal earthquakes.

The Stromboli volcano is 50 km off the coast of Italy. It has continuous explosions with an average of 10 per hour. From the geological record, there are evidences of 6 tsunamis in the 20th century that have been generated by volcanic landslides. On 30 December 2002, there

was a significant tsunami with run up of 10 m in some villages on the island. For tsunami warning, the main difficulty is to predict the source, proximity to shoreline and steep bathymetry. The present warning system for Stromboli became operational in 2015. It has: (i) A multi parametric monitoring network to identify transitions in eruptive activity, (ii) two plastic beacons located in front of Sciara del Fuoco (SdF) to identify real-time tsunami waves and transmit to advanced operational centre, and (iii) an acoustic warning system made of 8 sirens and one beeper interconnected by a dedicated very high frequency (VHF) radio network. Surface wave dispersion and short term average (STA) / long term average (LTA) ratio analysis is done for tsunami detection using bottom pressure sea level data from a set of monitoring buoys installed at 50 m water depth off the volcanic island. Warnings can be disseminated by activation of single or group of sirens that can be triggered manually or automatically.

16.3 METEOROLOGICAL TSUNAMIS: STATE-OF-THE-ART

Dr Ivica Vilibic provided an update (remotely) on the status of meteotsunami research, including the findings of the [First World Conference on Meteotsunamis](#). Meteorological tsunamis are long oceanic waves that have approximately the same spatial and temporal scales as ordinary tsunamis, and can affect coastal region in a similar destructive way, but are generated not by underwater earthquakes, volcanic explosions or landslides, but by atmospheric disturbances (hurricanes, frontal passages, squall lines, atmospheric gravity waves or by jumps of atmospheric pressure). There are numerous reports of damages due to meteotsunamis world-wide, leading to a meteotsunami research boom in recent years. The First World Conference on Meteotsunamis was held in Croatia during 8–11 May 2019. It drew the participation of 60 scientists from 18 countries comprising researchers, operational services and managers. Sixty-one presentations were made during this conference that highlighted several issues important for future meteotsunami research and building forecasting capabilities. They included: (i) the lack of quality-checked global sea level and ancillary data at a minute resolution available at one-stop-shop, (ii) the introduction of new technologies capable for measuring meteotsunami parameters at high resolutions, (iii) numerical modelling at high resolutions, (iv) understanding of processes, (v) hazard and risk assessment for meteotsunamis, (vi) meteotsunami forecasting and early-warning systems, and (vii) raising awareness for populations at endangered locations.

16.4 INTRODUCTION AND IMPLEMENTATION OF INDONESIA NON-TECTONIC TSUNAMI SYSTEM (INATNT)

Mr Januar ARIFIN provided an update (remotely) on the Indonesian Tsunami Early Warning System (InaTEWS) that was established at the Indonesian Agency for Meteorology, Climatology and Geophysics (BMKG) after the 26 December 2004 tsunami. Inaugurated in 2008, the system functions based on seismic and sea level monitoring as well as tsunami modelling. The tsunami that struck the coasts of Banten and Lampung on 22 December 2019 following the eruption of Anak Krakatau volcano highlighted the ineffectiveness of InaTEWS to detect such non-tectonic tsunamis. There are issues with the non-availability of non-tectonic tsunami standard operating procedures, that sea level observation data is still not integrated, and the need for automatic sea level anomaly detection system. To overcome these issues, InaTEWS developed an integrated system for the analysis of sea level observation data from tide gauges (BMKG, BIG, IOC), automatic weather stations (AWSs) for water level, tsunami buoys, and high frequency (HF) radars. An automatic sea level anomaly detection algorithm was implemented that uses high pass filtered STA/LTA ratio for tsunami detection. A standard operating procedure is being developed to continuously monitor seismic signals from volcanic explosions and flank collapses and sea level variations caused by tsunamis to provide warnings for volcanic triggered tsunamis.

16.5 THE CARIBBEAN EXPERIENCE ON TSUNAMI PROCEDURES FOR VOLCANO CRISES, NON-SUBDUCTION ZONE TSUNAMIS AND THE VOLCANIC CARIBE WAVE 19 EXERCISE

Dr Valerie Clouard provided an update on the work of the ICG/CARIBE-EWS Task Team that was set up in 2016 following the Kick ém Jenny (KeJ) submarine eruption (July 2015) to identify procedures to follow for volcanic crises. The Task Team recommended that volcano observatories should be identified as the primary entities responsible for determining the potential of a volcano induced tsunami threat. Should the TSP detect a volcano-induced tsunami, forecast bulletins will be issued in accordance with established procedures, independent of source. It was also suggested to prepare a Memorandum of Understanding (MoU) between the volcano observatories and the TSP. The team also presented a list of 44 potentially threatening volcanoes, monitored by 11 volcano observatories. During the scientific expert meeting in the Lesser Antilles (Martinique, 2019) tsunamis from non-seismic sources including volcanoes, mud volcanoes, non-subduction earthquakes, submarine landslides, etc. were discussed. The Caribe Wave 19 exercise (IOC/2018/TS/141) included a volcano-generated tsunami (KeJ) and it brought to light that effective PTWC procedures for such an event would likely require being alerted to an unexpected tsunami signal on a coastal sea-level gauge.

16.6 NON-SUBDUCTION ZONE FAULTS AND TSUNAMI POTENTIAL

Dr Elizabeth Vanacore made a presentation on the tsunami potential of non-subduction zone faults. Strike-slip tsunami generation is often due to pop-up structures generated by fault geometry, land or shoreline displacement, oblique motion or the activation of multiple faults including normal and thrust faults. For non-subduction tsunamigenic events, primary source regions tend to be complex systems of normal and strike-slip faults adjacent to the plate boundaries. In addition, fault interactions and secondary landslides (e.g. Puerto Rico 1918, Palu 2019) may also influence tsunami generation. In complex source regions, it is possible that not all faults are known. Regional expertise and studies to better determine systems and tsunamigenic potentials are needed.

16.7 ATYPICAL TSUNAMI SOURCES IN THE NEAM REGION

Dr Francois Schindele provided an update on atypical tsunami sources in the NEAM region. In the NEAM region, most tsunamis are caused by atypical sources with mix of normal, strike slip and thrust faults. It is important to define what are typical and atypical sources. If earthquake sources on subduction boundaries (reverse faults) are categorised as typical sources, then earthquakes in subduction zones with slower and much larger slip (2–4 times), earthquake sources not on subduction zone boundaries, volcanic eruptions, and coastal and submarine landslides should be considered as atypical. It may be more appropriate to call atypical sources as “non-mega thrust and aseismic” sources. Further work is needed by the ad-hoc team in the next intersessional period, and it was agreed that Dr Schindele and Mr Nishimae will coordinate this effort in consultation with all other members.

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

17. REVIEW OF ACTION ITEMS AND RECOMMENDATIONS TO THE TOWS-WG

17.1 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.

17.2 ACTIONS:

Action 1: Team comprising Sarah-Jayne McCurrach (PTWS), Yuelong Miao and Harkunti Rahayu (IOTWMS), Elizabeth Vanacore and Mary Regifo (CARIBE-EWS), and Öcal 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 Schindele 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 Schindele, Weniza, Jacopo

Selva, David Coetzee, Valerie Clouard, Elizabeth Vanacore, and Ivica Vilibic to prepare a document on best practices for hazard assessment, monitoring and responding to tsunamis from those sources for the next TOWS meeting.

18. CLOSE OF MEETING

Dr McCreery closed the meeting at 05:30 pm and thanked the participants for their contribution to a highly productive meeting.

Appendix 1

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

Intergovernmental Oceanographic Commission, UNESCO
18–19 February 2020, Paris, France

Provisional Agenda and Timetable

Task Team Members:

- Charles McCreery, Pacific Tsunami Warning Center (NOAA, Hawaii, USA) – PTWS
- Yuji Nishimae, Japan Meteorological Agency (Japan) – PTWS
- Francois Schindele, Centre d'alerte aux tsunamis (France) – NEAMTWS
- Fernando Carrilho, Portuguese Sea and Atmosphere Institute (Portugal) – NEAMTWS
- Elizabeth Vanacore, Seismologist, Puerto Rico Seismic Network (USA) – CARIBE-EWS
- Wilfried Strauch, Central American Tsunami Advisory Centre (Nicaragua) – CARIBE-EWS
- Mohammad Mokhtari, International Institute of Seismology and Earthquake Engineering (Iran)–IOTWMS
- Pattabhi Rama Rao, Indian National Centre for Ocean Information Services (India) – IOTWMS

Day 1: Tuesday, February 18, 2020

Item	Time	Topic	Reference	Lead
1	0900-0915	Opening and Session Organization <ul style="list-style-type: none"> • Registration • Overview of meeting logistics, introduction of participants, review of the agenda, etc. 		Chip McCreery
2	0915-0945	Review of Action Items from the Previous Meeting	Summary Report, TOWS-WG, Twelfth Meeting, Annex IV, Section 16.2, page 13	Chip McCreery ICG Representatives
3	0945-1015	Review the Status of Implementation of the TOWS-WG Requests to the TTTWO	Summary Report, TOWS-WG, Twelfth Meeting, Annex II, page 3	Chip McCreery ICG Representatives
4	1015-1115	Tsunami Watch Operations - Current Status and Plans in all ICGs		ICG Representatives
11.15 – 11.30 Break				

Item	Time	Topic	Reference	Lead
5	1130-1300	Significant Operational Events Since Last Meeting Presentation on New Zealand DART Buoy Network (Ken Gledhill)		Joint Session with TTDMP
13.00 – 14.00 Lunch				
6	1400-1430	Tsunami Glossary Update		Joint Session with TTDMP
7	1430-1515	Development of KPIs in relation with Sendai Framework Indicators	Summary Report, TOWS-WG, Twelfth Meeting, Annex III, Section 6, page 4, Annex IV, Section 7, page 6	Joint Session with TTDMP
15.15 – 15.30 Break				
Item	Time	Topic	Reference	Lead
8	1530-1630	Local Source Tsunami SOPs – best practice for warning and response	Summary Report, TOWS-WG, Twelfth Meeting, Annex III, Section 7, Page 4, Annex IV, Section 8, page 7	Joint Session with TTDMP
9	1630-1700	NTWC Competency Framework	Summary Report, TOWS-WG, Twelfth Meeting, Annex III, Section 8, Page 4, Annex IV, Section 9, page 7	Joint Session with TTDMP
End of Day 1				

Day 2: Wednesday, February 19, 2020

Item	Time	Topic	Reference	Lead
10	0900-1000	Planning for the Ocean Decade	Summary Report, TOWS-WG, Twelfth Meeting, Annex III, Section 9, Page 4, Annex IV, Section 10, page 7-9	Joint Session with TTDMP
11	1000-1100	Updates to Area of Coverage and ESZ Maps of the ICGs	Summary Report, TOWS-WG, Twelfth Meeting, Annex IV, Section 11, page 9-10	ICG Representatives
11.00 – 11.15 Break				
12	1115-1200	Harmonization of Format and Content of TSP Operational Products across ICGs and TSPs		ICG Representatives
13	1200-1230	Products for Maritime Community	Summary Report, TOWS-WG, Twelfth Meeting, Annex IV, Section 13, page 11; Annex IV, Appendix 4	ICG Representatives

Item	Time	Topic	Reference	Lead
14	1230-1300	Global Public Access to Tsunami Threat Information	Summary Report, TOWS-WG, Twelfth Meeting, Annex IV, Section 14, page 11-12	ICG Representatives
13.00 – 14.00 Lunch				
15	1400-1430	Other Issues <ul style="list-style-type: none"> • Optimal Design of Sea-level networks • Updates to the GSSD • QC and Assurance of tide gauge data for tsunami warning 	Summary Report, TOWS-WG, Twelfth Meeting, Annex IV, Section 15, page 12	ICG Representatives
16	1430-1600	Handling of Tsunamis from Non-Seismic Sources and Non-subduction Zone Earthquakes	Summary Report, TOWS-WG, Twelfth Meeting, Annex IV, Section 12, page 10-11	ICG Representatives, TTTWO sub team - Short presentations by Yuji Nishimae, Francois Schindele, Jacopo Selva, Valerie Clouard, Elizabeth Vanacore, Karyono (remote), Ivica Vilibic (remote)
16.00 – 16.15 Break				
17	1615-1700	Recommendations and Actions for Reporting to the TOWS-WG		Chip McCreery IOC-Representative
18	1700 - 1730	Conclusion		Chip McCreery IOC-Representative
Meeting Close				

Appendix 2

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

18–19 February 2020, Paris

SIGNIFICANT OPERATIONAL EVENTS IN THE INTER-SESSIONAL PERIOD

Date	Place	Mw Initial	Mw CMT	Mw USGS	System	Center	Action	Ampl.
14/07/19	Broome	6.6		6.4	IOTWMS	JATWC	No Threat	
		6.9			IOTWMS	InaTEWS	No Threat	
		6.9			IOTWMS	ITEWC	No Threat	
02/08/19	SW of Sumatra	7.1		6.9	IOTWMS	JATWC	No Threat	
		7.0			IOTWMS	InaTEWS	No Threat	
		6.8			IOTWMS	ITEWC	Threat	
14/05/19	New Britain	7.5	7.7	7.6	PTWS	PTWC		
15/06/19	Kermadec Is	7.3	7.4	7.3	PTWS	PTWC		14 cm
14/11/19	Molucca Sea	7.1	7.4	7.1	PTWS	PTWC		11 cm
28/01/20	Cuba	7.7	7.3	7.7	CARIBE	PTWC		11 cm
26/11/19	Albania	6.0		6.4	NEAMTWS	NOA	Advisory	
		6.5			NEAMTWS	KOERI	Advisory	
		6.5			NEAMTWS	INGV	Advisory	
03/07/19	Stromboli	Volcano			NEAMTWS		No TSP Action	40 cm

Only events with USGS Mw of ≥ 6.5 and/or events that caused significant tsunamis are listed in the above table.

Appendix 3

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

**Draft IOTWMS Communique on Open access to real-time, fit-for-purpose data
for effective tsunami detection and warning**

February 2020, Paris

Among the many global challenges we face today the IOC Tsunami Programme continues to stand as an exemplar of what can be achieved when countries come together to cooperate in pursuit of a common goal.

In the aftermath of the 2004 Indian Ocean tsunami, this community rallied and committed to build a sustainable, globally integrated tsunami early warning “system of systems” – appropriately designed and supported to provide adequate protection at local, regional and global scales.

In the 15 years since making that commitment, we have achieved a great deal together. Regional tsunami warning systems have been established in the Indian Ocean, Caribbean and North-eastern Atlantic and Mediterranean, joining the system established in the Pacific Ocean in 1965. This globally integrated “system of systems” has proven to be very effective in mitigating the impact of tsunamis and saving lives.

Nonetheless, the recent tragedies of the Palu and Sunda Strait tsunamis in 2018 highlight, once again, the need for our continued, cooperative and sustained effort. They highlight also, that our work is not yet done. Together, we must increase our efforts to:

- identify and understand all potential sources of tsunami;
- assess and mitigate the risks they pose at all scales – local, regional and global;
- establish and maintain effective tsunami awareness, preparedness and response programmes in all coastal communities; and
- build on our efforts to provide effective, sustainable, rapid and real-time tsunami detection and warning dissemination systems that ensure actionable information reaches all at-risk communities, quickly.

We are seeing new research outcomes from the scientific community every year, demonstrating new techniques for a modern, augmented tsunami early warning system. There are also renewed efforts to strengthen our monitoring capability, with campaigns to introduce high-density, local GNSS networks, ocean-bottom seismometers, and SMART cables. These technologies and techniques look to be powerful additions to our international tsunami early warning “system of systems”. Realising this vision will require multi-billion-dollar investment and many years of coordinated effort. The effectiveness of that money and effort, however, will still hinge on one fundamental undertaking – that the data acquired by these systems is made open and available, in real-time, to all who need it.

Open and reliable access to fit-for-purpose data is fundamental to tsunami early warning: real-time seismic and GNSS data enable tsunami source detection, characterisation and tsunami early warning; high resolution bathymetry and coastal topography data underpin reliable tsunami and inundation forecasting; and real-time sea-level data provides confirmation and enables real-time recalibration of those forecasts and warnings.

We recognise and applaud all who continue to demonstrate their commitment to tsunami early warning through the provision of open seismic, GNSS, and sea-level data, in real-time –

government and non-government organizations, educational and private institutions, alike. But there are regions, still, where access to the real-time, fit-for-purpose data that is necessary for effective, timely and robust tsunami detection and warning is inadequate. Monitoring networks and data exist in these areas, but the data are restricted – either delayed or wholly contained within institutional, national, or regional boundaries.

The tsunami early warning community cannot afford the concept of “insiders and outsiders”. Surely we have not forgotten that the 2004 tsunami had direct and devastating impact on 12 countries – Indonesia, Malaysia, Thailand, Myanmar, India, Sri Lanka, Maldives, Somalia, Kenya, Tanzania, Seychelles and Madagascar. More than 170 thousand people were killed and more than 150 thousand are still listed as missing. Over 1.8 million people were displaced, and the estimated recovery cost exceeded 10 billion dollars. Tsunamis do not recognise national or regional boundaries, and data everywhere contributes to providing timely warning, and robust forecasting. One country’s near-field threat will be another’s regional- or far-field threat. We must recognise and always remember that we are better and stronger when we work together, as a community, for a common goal.

The single most impactful undertaking that can improve tsunami early warning for all communities right now, today, requires no multi-billion-dollar capital investment. It requires, simply, political and institutional will. A willingness to adopt and actively practice open data policies that will support faster, more accurate and more reliable tsunami source characterisation and warning, for all.

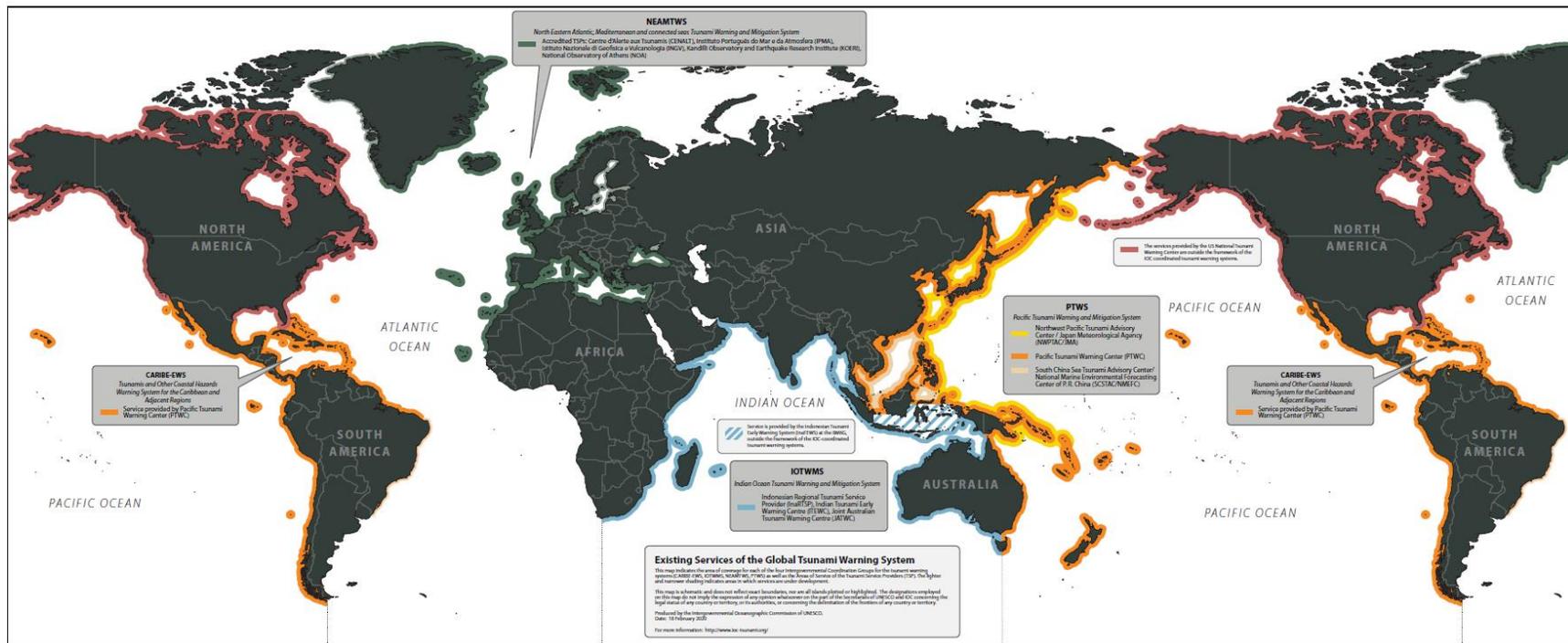
We, the regional tsunami service providers and national tsunami warning centres of the Indian Ocean Tsunami Warning and Mitigation System urge all countries and institutions to adopt and practice open data policies for real-time seismic, GNSS and sea-level data.

Appendix 4

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

19–20 February 2019, Paris

Revised Area of Service Map



ANNEX V

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ANNEX VI

LIST OF ACRONYMS

ANACOM	Autoridade Nacional de Comunicações (Portugal)
AoS	Area of Service
AWS	Automatic Weather Stations
BMKG	Indonesian Agency for Meteorological, Climatological and Geophysics
CAP	Common Alert Protocol
CATAC	Central America Tsunami Advisory Center
CARIBE-EWS	Tsunami and Other Coastal Hazards Warning System for the Caribbean and Adjacent Regions
CARIBE WAVE	Caribbean Wave Exercise
CEPRENAC	Coordination Center for the Prevention of Natural Disasters in Central America
CIFDP	Coastal Inundation Forecasting Demonstration Project
CIFI	Inundation Forecasting Initiative
CENALT	CENtre d'Alerte aux Tsunamis, France
CMT	Centroid Moment Tensor
CTIC	Caribbean Tsunami Information Center
CTSP	Candidate Tsunami Service Provider
CTWP	Caribbean Tsunami Warning Programme
DART	Deep-ocean Assessment and Reporting of Tsunamis
DONET	Dense Oceanfloor Network System for Earthquakes and Tsunamis
DRR	Disaster Risk Reduction
ESZ	Earthquake Source Zone
EC	Executive Council
GNSS	Global Navigation Satellite System
GOOS	Global Ocean Observing System (IOC)
GSSD	Global Service Definition Document
GTS	Global Telecommunication System (WMO)
HAB	Harmful Algal Bloom
HF	High Frequency
ICG	Intergovernmental Coordination Group
ICG/CARIBE-EWS	Intergovernmental Coordination Group for the Tsunami and Other Coastal Hazards Warning System for the Caribbean and Adjacent Regions
ICG/IOTWMS	Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System
ICG/NEAMTWS	Intergovernmental Coordination Group for the Tsunami Early Warning and Mitigation System in the North-eastern Atlantic, the Mediterranean and Connected Seas
ICG/PTWS	Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System
IHO	International Hydrographic Organization

IMO	the International Maritime Organization
InaTEWS	Indonesian Tsunami Early Warning System
Inatnt	Indonesia non tectonic tsunami system
INGV	Istituto Nazionale di Geofisica e Vulcanologia (Italy)
IOC	Intergovernmental Oceanographic Commission
IOTIC	Indian Ocean Tsunami Information Centre
IOTR	Indian Ocean Tsunami Ready
IOTWMS	Indian Ocean Tsunami Warning and Mitigation System
IOWave	Indian Ocean Wave Exercise
IPMA	Instituto Português do Mar e da Atmosfera
ITEWC	Indian Tsunami Early Warning Centre
ITIC	International Tsunami Information Center
ITST	International Tsunami Survey Team
JATWC	Joint Australian Tsunami Warning Centre
JCB	Joint Collaborative Board (of WMO-IOC)
JCOMM	Joint Technical Commission for Oceanography and Marine Meteorology
JMA	Japan Meteorological Agency
JRC	Joint Research Centre
KeJ	Kick ém Jenny (submarine eruption)
KOERI	Kandilli Observatory and Earthquake Research (Turkey)
KPI	Key Performance Indicators
M	Magnitude
MHEWS	Multi-Hazard Early Warning Systems
M_w	Moment Magnitude
MoU	Memorandum of Understanding
NAVAREA	Navigational Area (within the World Wide Navigational Service)
NEAM	North-eastern Atlantic, the Mediterranean and Connected Seas
NEAMTIC	Tsunami Information Centre for the North-eastern Atlantic, the Mediterranean and Connected Seas
NEAMTWS	Tsunami Early Warning and Mitigation System in the North-eastern Atlantic, the Mediterranean and Connected Seas
NOA	National Observatory of Athens (Greece)
NOAA	National Oceanic and Atmospheric Administration
NTWC	National Tsunami Warning Center
NWPTAC	North West Pacific Tsunami Advisory Center
OTGA	Ocean Teacher Global Academy
PacWave	Pacific Wave Exercise
PTWC	Pacific Tsunami Warning Centre
PTWS	Pacific Tsunami Warning and Mitigation System
RIFT	Real-time Inundation Forecasting of Tsunamis
SC	Steering Committee
SCSTAC	South China Sea Tsunami Advisory Centre
SDG	Sustainable Development Goals
SIDS	Small Island developing States

SMART	Science Monitoring And Reliable Telecommunications
SOP	Standard Operating Procedure
STA/LTA	Short Term Average / Long Term Average
TEMPP	Tsunami Evacuation Maps, Plans and Procedures
TIC	Tsunami Information Centres
TNC	Tsunami National Contact
TOR	Terms of Reference
TOWS-WG	Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems
TSP	Tsunami Service Provider
TSU	Tsunami Unit
TSUCAT	Tsunami Coastal Assessment Tool
TSUMAPS NEAM	Probabilistic Tsunami Hazard Maps for the NEAM Region
TT	Task Team
TTDMP	Task Team on Disaster Management and Preparedness
TTT	Tsunami Travel Time
TTTRP	Task Team on Tsunami Recognition Programme
TTTWO	Task Team on Tsunami Watch Operations
TWFP	Tsunami Warning Focal Point
UN	United Nations
UNDP	United Nations Development Programme
UNDRR	United Nations Office for Disaster Risk Reduction
UNESCAP	UN Economic and Social Commission for Asia and the Pacific
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNGA	United Nations General Assembly
UNESDOC	UNESCO Digital Library
USAID/OFDA	United States Agency for International Development/Office of U.S. Foreign Disaster Assistance
USGS	United States Geological Survey
USD	United States Dollars
VHF	Very High Frequency
WCATWC	West Coast/Alaska Tsunami Warning Center
WG	Working Group
WIS	WMO Information System
WMO	World Meteorological Organization
WTAD	World Tsunami Awareness Day
WWNWS-SC	World-Wide Navigational Warning Service Sub-Committee

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 CO₂ 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 CO₂ 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 CO2 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 CO₂ 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 CO₂ Advisory Panel, Honolulu, Hawaii, U.S.A, 2002 **(electronic copy only)**
181. IOC Workshop on the Establishment of SEAGOOS in the Wider Southeast Asian Region, Seoul, Republic of Korea, 2001 (SEAGOOS preparatory workshop) **(electronic copy only)**
182. First Session of the IODE Steering Group for the Resource Kit, USA, 19–21 March 2001
183. Fourth Session of the IOC-IUCN-NOAA Consultative Meeting on Large Marine Ecosystems (LMEs), France, 2002
184. Seventh Session of the IODE Group of Experts on Marine Information Management (GEMIM), France, 2002 **(electronic copy only)**
185. Sixth Session of IOC/WESTPAC Coordinating Committee for the North-East Asian Regional - Global Ocean Observing System (NEAR-GOOS), Republic of Korea, 2001 **(electronic copy only)**
186. First Session of the Global Ocean Observing System (GOOS) Capacity Building Panel, Switzerland, 2002 **(electronic copy only)**
187. Fourth Session of the ad hoc Advisory Group for IOCARIBE-GOOS, 2002, Mexico **(also printed in French and Spanish)**
188. Fifth Session of the IOC Editorial Board for the International Bathymetric Chart of the Western Indian Ocean (IBCWIO), Mauritius, 2000
189. Third session of the Editorial Board for the International Bathymetric Chart of the Western Pacific, Chine, 2000
190. Third Session of the Coastal Ocean Observations Panel and GOOS Users' Forum, Vietnam, 2002
191. Eighth Session of the IOC Consultative Group on Ocean Mapping, Russian Federation, 2001
192. Third Session of the Advisory Body of Experts on the Law of the Sea (IOC/ABE-LOS), Lisbon, 2003 **(also printed in French)**
193. Extraordinary Session of the Joint IOC-WMO-CPPS Working Group on the Investigations of 'El Niño', Chile, 1999 **(Spanish only; electronic copy only)**
194. Fifth Session of the IOC-WMO-UNEP-ICSU Steering Committee of the Global Ocean Observing System, France, 2002
195. Sixth Session of the IOC-WMO-UNEP-ICSU Steering Committee of the Global Ocean Observing System, South Africa, 2003
196. Fourth Session of the Coastal Ocean Observations Panel, South Africa, 2002 **(electronic copy only)**
197. First Session of the JCOMM/IODE Expert Team On Data Management Practices, Belgium, 2003 **(also JCOMM Meeting Report No. 25)**
198. Fifth Session of the IOC-IUCN-NOAA Consultative Meeting on Large Marine Ecosystems (LMEs), Paris, 2003
199. Ninth Session of the IOC Consultative Group on Ocean Mapping, Monaco, 2003 **(Recommendations in English, French, Russian and Spanish included)**
200. Eighth Session of the IOC Group of Experts on the Global Sea level Observing System (GLOSS), France, 2003 **(electronic copy only)**
201. Fourth Session of the Advisory Body of Experts on the Law of the Sea (IOC/ABE-LOS), Greece, 2004 **(also printed in French)**
202. Sixth Session of the IOC-IUCN-NOAA Consultative Meeting on Large Marine Ecosystems (LMEs), Paris, 2004 **(electronic copy only)**
203. Fifth Session of the Advisory Body of Experts on the Law of the Sea (IOC/ABE-LOS), Argentina, 2005 **(also printed in French)**
204. Ninth Session of the IOC Group of Experts on the Global Sea level Observing System (GLOSS), France, 2005 **(electronic copy only)**
205. Eighth Session of the IOC/WESTPAC Co-ordinating Committee for the North-East Asian Regional – Global Ocean Observing System (NEAR-GOOS), China, 2003 **(electronic copy only)**
206. Sixth Meeting of the Advisory Body of Experts on the Law of the Sea (IOC/ABE-LOS), Spain, 2006 **(also printed in French)**
207. Third Session of the Regional Forum of the Global Ocean Observing System, South Africa, 2006 **(electronic copy only)**
208. Seventh Session of the IOC-UNEP-IUCN-NOAA Consultative Meeting on Large Marine Ecosystems (LMEs), Paris, 2005 **(electronic copy only)**
209. Eighth Session of the IOC-UNEP-IUCN-NOAA Consultative Meeting on Large Marine Ecosystems (LMEs), Paris, 2006 **(electronic copy only)**
210. Seventh Meeting of the IOC Advisory Body of Experts on the Law of the Sea (IOC/ABE-LOS), Gabon, 2007 **(bilingual English/French)**
211. First Meeting of the IOC Working Group on the Future of IOC, Paris, 2008 **(Executive Summary in English, French, Russian and Spanish included)**
212. First meeting of the Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG), Paris, 3–4 April 2008 **(Executive Summary in English, French, Russian and Spanish included)**
213. First Session of the Panel for Integrated Coastal Observation (PICO-I), Paris, 10–11 April 2008 **(electronic copy only)**
214. Tenth Session of the IOC Group of Experts on the Global Sea level Observing System (GLOSS), Paris, 6–8 June 2007 **(electronic copy only)**
215. Eighth Meeting of the IOC Advisory Body of Experts on the Law of the Sea (IOC/ABE-LOS), Paris, 21–25 April 2008 **(bilingual English/French)**
216. Fourth Session of the Global Ocean Observing System (GOOS) Regional Alliances Forum (GRF), Guayaquil, Ecuador, 25–27 November 2008 **(electronic copy only)**
217. Second Session of the Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG), Paris, 27 March 2009 **(Executive Summary in English, French, Russian and Spanish included)**
218. Ninth Meeting of the IOC Advisory Body of Experts on the Law of the Sea (IOC/ABE-LOS), Paris, 30 March–3 April 2009 **(bilingual English/French)**
219. First Session of the IOC-SCOR International Ocean Carbon Coordination Project (IOCCP) Scientific Steering Group (also IOCCP Reports, 3), Broomfield, Colorado, U.S.A., 1 October 2005 **(electronic copy only)**
220. Second Session of the IOC-SCOR International Ocean Carbon Coordination Project (IOCCP) Scientific Steering Group (also IOCCP Reports, 6), Paris, France, 20 April 2007 **(electronic copy only)**
221. Third Session of the IOC-SCOR International Ocean Carbon Coordination Project (IOCCP) Scientific Steering Group (also IOCCP Reports, 10), Villefranche-sur-mer, France, 3–4 October 2008 **(electronic copy only)**
222. Fourth Session of the IOC-SCOR International Ocean Carbon Coordination Project (IOCCP) Scientific Steering Group (also IOCCP Reports, 15), Jena, Germany, 14 September 2009 **(electronic copy only)**
223. First Meeting of the joint IOC-ICES Study Group on Nutrient Standards (SGONS) (also IOCCP Reports, 20), Paris, France, 23–24 March 2010 **(Executive Summary in E, F, R, S included)**
224. Third Session of the Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG), Lisbon, Portugal, 5–6 May 2010 **(Executive Summary in English, French, Russian and Spanish included)**
225. Eleventh Session of the IOC Group of Experts on the Global Sea level Observing System (GLOSS), Paris, 13–15 May 2009 **(electronic copy only)**
226. Second Session of the Panel for Integrated Coastal Observation (PICO-II), Paris, 24–26 February 2009 **(electronic copy only)**
227. First meeting of the Task Team on Seismic Data Exchange in the South West Pacific of the ICG/PTWS Regional Working Group for the Southwest Pacific, Port Vila, Vanuatu, 19–20 October 2009 **(electronic copy only)**
228. Fourth Session of the Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG), Paris, France, 20–21 March 2011 **(Executive Summary in English, French, Russian and Spanish included)**
229. Second Session of the IODE Steering Group for Ocean Teacher (SG-OT), Miami, Florida, 11–15 April 2011
230. First Meeting of the Inter-ICG Task Team 1 on Sea Level Monitoring for Tsunami (Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG), Seattle, USA, 29 November–1 December 2010

231. First Meeting of the Inter-ICG Task Team 2 on Disaster Management and Preparedness (Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG), Seattle, USA, 29 November–1 December 2010
232. First Meeting of the Inter-ICG Task Team 3 on Tsunami Watch Operations (Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG), Seattle, USA, 29 November–1 December 2010
233. Primera Reunión del Grupo de Trabajo Regional para América Central del Grupo Intergubernamental de Coordinación del Sistema de Alerta contra los Tsunamis y Atenuación de sus Efectos en el Pacífico (ICG/PTWS), Managua (Nicaragua) del 4 al 6 de noviembre de 2009 (**Resumen dispositivo en español e inglés**)
234. Segunda Reunión del Grupo de Trabajo Regional para América Central del Grupo Intergubernamental de Coordinación del Sistema de Alerta contra los Tsunamis y Atenuación de sus Efectos en el Pacífico (ICG/PTWS), San Salvador (El Salvador) del 28 al 30 de septiembre de 2011 (**Resumen dispositivo en español e inglés**)
235. First Session of the Joint IODE-JCOMM Steering Group for the Global Temperature-Salinity Profile Programme (SG-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**)