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)

First Meeting

UNESCO Headquarters, Paris, France
3–4 April 2008

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EXECUTIVE SUMMARY

The TOWS-WG reviewed previous work by the GOWHMS. The Framework document was considered and a final version agreed.

The TOWS-WG considered the status of the tsunami warning Systems and of other subsidiary bodies insofar as it impacted the mandate of the TOWS-WG. Capacity building and information exchange and outreach were given particular attention.

The TOWS-WG believes a global “core” network of sea level tide gauges should be defined by JCOMM/GLOSS for tsunami and ocean hazards, building on the GLOSS core for climate wherever possible. TOWS-WG further believes the tsunameter Partnership should transition to an Action Group under the JCOMM/DBCP, to exploit synergies and to encourage a global role.

The TOWS-WG believes IOC should adopt standards and endorse practices for the tsunami Systems as a whole and, to this end, will undertake a study of guidelines for regional and national tsunami watch standards. It also supported the publication of standardized procedures to evaluate actions taken by regional and national Tsunami Warning Centres during tsunamigenic events.

The TOWS-WG noted some issues with exchange of seismic data, including interoperability. Real time data sharing and optimising the timely use of existing solutions were two factors. The TOWS-WG proposed creating a small task team to examine the issues and report back to the next meeting.

The WG were apprised of a number of remaining telecommunication issues. The TOWS-WG agreed to undertake an analysis of need, including how to access GTS information and the issue of access beyond the NMHSs.

The TOWS-WG noted that IOC capability for coastal hazards resides in a number of primary and secondary subsidiary bodies. It also noted the emergence of the ICSU Scientific Planning Group in disasters caused by natural hazards and agreed that, in concert with the Ocean Sciences Program, it should test the potential benefits of working with ICSU in this area. The TOWS-WG further noted the need for enhanced attention to ecosystem observations to support coastal hazard studies and vulnerability and post-hazard assessment programs.

The TOWS-WG noted the many references to the need for high-resolution bathymetric data and digital elevation models, including in the GOWHMS Framework document. The TOWS-WG suggests the Executive Council give urgent attention to this matter.

The TOWS-WG noted that Capacity Building requirements often transcended the boundaries of the ICG, and sometimes of IOC itself. Dialogue and coordination with potential donors/funders should be at a high level, to ensure consistency in messages and actions and optimize the response. The WG may be able to play a role. In a similar vein, the TOWS-WG believes information exchange and outreach should be coordinated a high-level, notwithstanding the fact that some actions may be region specific.

In general, the TOWS-WG believes it may be timely to consolidate and transition (or share) work with other bodies of IOC in a number of areas (science, observation, services).

The TOWS-WG made a number of observations on the governance and mode of operation of the ICGs, noting some potential inefficiency. There should be a number of standing items in each ICG agenda. The TOWS-WG noted that the interaction between the ICGs and the Governing Body was at times both ineffective and inefficient. The TOWS-WG

asks the Executive Council to consider tasking the WG with review of the input from the ICGs with a view to streamlining and rationalising the input so that only those matters requiring decision were tabled, and in such a way as to harmonise the work of the Commission and introduce consistency.

The TOWS-WG agreed to review the organisation and coordination among working groups of the ICGs.

High-level coordination of funding was considered, including support for the Secretariat. Tight and effective strategic planning, efficient coordination, and clear priorities were highlighted. The WG also recognized distinct advantages in acting “as one” within the IOC, e.g. in working with ISDR and its partners.

RÉSUMÉ ANALYTIQUE

Le TOWS-WG a étudié les travaux antérieurs du GOHWMS. Le Document-cadre a été examiné et une version finale a été adoptée.

Le TOWS-WG a examiné le statut des Systèmes d'alerte aux tsunamis et d'autres organes subsidiaires dans la mesure où il avait des incidences sur son mandat. Le renforcement des capacités, l'échange d'informations et le champ d'action ont fait l'objet d'une attention particulière.

Le TOWS-WG estime que la JCOMM/GLOSS devrait définir un réseau mondial « de base » de marégraphes pour les tsunamis et les aléas océaniques en s'appuyant, autant que possible, sur le réseau de base du GLOSS pour le climat. Le TOWS-WG considère en outre que le Partenariat international pour les tsunamimètres devrait devenir un Groupe d'action relevant de la JCOMM/DBCP afin de tirer parti des synergies et de favoriser un rôle mondial.

Le TOWS-WG estime que la COI devrait adopter des normes et approuver des pratiques pour les Systèmes d'alerte aux tsunamis dans leur ensemble et, à cette fin, réaliser une étude des principes directeurs relatifs aux normes régionales et nationales en matière de veille aux tsunamis. Il s'est également prononcé en faveur de la publication de procédures normalisées pour l'évaluation des mesures prises par les Centres d'alerte aux tsunamis régionaux et nationaux lors de phénomènes tsunamigènes.

Le TOWS-WG a constaté quelques problèmes concernant l'échange de données sismiques, notamment en matière d'interopérabilité. Le partage des données en temps réel et l'optimisation du recours aux solutions existantes en temps utile en sont deux facteurs. Le TOWS-WG a proposé la création d'une équipe spéciale restreinte chargée d'examiner ces problèmes et de faire rapport à la prochaine réunion.

Le TOWS-WG a été informé d'un certain nombre de problèmes de télécommunication restant à résoudre. Il a décidé d'effectuer une analyse des besoins, notamment en ce qui concerne la manière d'accéder aux informations du SMT et la question de l'accès au-delà des services météorologiques et hydrologiques nationaux (NMHS).

Le TOWS-WG a noté que la compétence de la COI en matière d'aléas côtiers se situait dans un certain nombre d'organes subsidiaires principaux et secondaires. Il a également pris acte de l'émergence du Groupe de planification du CIUS en matière de catastrophes d'origine naturelle et a convenu de tester, de concert avec le Programme d'océanologie, les éventuels avantages d'une collaboration avec le CIUS dans ce domaine. Il a aussi jugé nécessaire d'accorder une plus grande attention aux observations des écosystèmes à l'appui des études menées sur les aléas côtiers ainsi que des programmes d'évaluation de la vulnérabilité et des effets de ces aléas.

Le TOWS-WG a pris note des nombreuses allusions, y compris dans le Document-cadre du GOHWMS, à la nécessité de disposer de données bathymétriques et de modèles numériques d'élévation haute résolution. Il suggère que le Conseil exécutif de la COI examine d'urgence cette question.

Le TOWS-WG a constaté que les exigences en matière de renforcement des capacités dépassaient souvent le cadre du GIC, et parfois de la COI elle-même. Le dialogue et la coordination avec les donateurs/bailleurs potentiels devraient avoir lieu à un haut niveau afin d'assurer la cohérence des messages et des actions et d'optimiser la réponse. Le Groupe de travail pourrait jouer un rôle à cet égard. Dans le même ordre d'idées, il estime que l'échange d'informations et le champ d'action devraient être coordonnés à un haut niveau, même si certaines actions peuvent être propres à une région.

D'une manière générale, le TOWS-WG estime qu'il est peut-être temps de fusionner et de répartir (ou partager) les travaux avec d'autres organes de la COI dans un certain nombre de domaines (sciences, observation, services).

Le TOWS-WG a fait plusieurs remarques concernant la gouvernance et le mode de fonctionnement des GIC, et attiré l'attention sur un certain risque d'inefficacité. Plusieurs points devraient figurer en permanence à l'ordre du jour de chaque GIC. Le TOWS-WG a noté que l'interaction entre les GIC et l'organe directeur était parfois aussi inopérante qu'inefficace. Il demande au Conseil exécutif d'envisager de lui confier l'examen de l'apport des GIC en vue de le rationaliser et de le simplifier, de sorte que seules les questions appelant une décision soient présentées, et ce de façon à harmoniser les travaux de la Commission et à assurer la cohérence.

Le TOWS-WG est convenu de procéder à un examen de l'organisation et de la coordination entre les groupes de travail des différents GIC.

Une coordination à un haut niveau du financement, y compris l'appui au Secrétariat, a été envisagée. La nécessité d'une planification stratégique rigoureuse et effective, d'une coordination efficace et de priorités claires a été soulignée. Le Groupe de travail a également reconnu les avantages certains de l'« unité d'action » pour la COI, par exemple en collaborant avec le SIPC et ses partenaires.

RESUMEN DISPOSITIVO

El Grupo de Trabajo sobre sistemas de alerta contra tsunamis y otros peligros relacionados con el nivel del mar y atenuación de sus efectos (TOWS-WG) pasó revista a la labor realizada anteriormente por el GOWHMS. Se examinó el Documento Marco y se aprobó una versión final.

El TOWS-WG examinó la situación de los sistemas de alerta contra los tsunamis y de otros órganos subsidiarios, en la medida en que incidía en su mandato. Se prestó especial atención al aumento de capacidades y al intercambio y la difusión de información.

El TOWS-WG estima que el GLOSS de la JCOMM debería definir una red “básica” mundial de mareógrafos en relación con los tsunamis y otros peligros oceánicos, aprovechando la red básica del GLOSS para el clima donde sea posible. El TOWS-WG considera además que la International Tsunameter Partnership (ITP) debería transformarse en un Grupo de Acción adscrito al DBCP de la JCOMM, a fin de aprovechar las sinergias y propiciar un funcionamiento de ámbito mundial.

El TOWS-WG opina que la COI debería adoptar normas y avalar prácticas para el conjunto de los sistemas de alerta contra tsunamis y, con ese fin, iniciará un estudio de las directrices relativas a las normas nacionales y regionales en materia de vigilancia de los tsunamis. El TOWS-WG apoyó también la publicación de procedimientos normalizados para evaluar las medidas adoptadas por los centros nacionales y regionales de alerta contra los tsunamis cuando se han producido estos fenómenos.

El TOWS-WG tomó nota de algunos problemas relativos al intercambio de datos sísmicos, entre ellos la compatibilidad operacional. Dos factores considerados fueron el intercambio de datos en tiempo real y la optimización del uso oportuno de las soluciones existentes. El TOWS-WG propuso que se creara un Equipo Especial restringido que examine estos temas y le presente un informe al respecto en su próxima reunión.

El Grupo de Trabajo recibió información acerca de diversos asuntos relativos a las telecomunicaciones que siguen pendientes. Acordó iniciar un análisis de las necesidades, comprendida la manera de acceder a la información del SMT y la cuestión del acceso fuera de los servicios meteorológicos e hidrológicos nacionales (NMHS).

El TOWS-WG tomó nota de que la competencia de la COI en materia de amenazas costeras dimana de varios órganos subsidiarios primarios y secundarios. También tomó nota de la creación del Grupo de Planificación Científica del ICSU sobre Desastres Naturales y acordó que, en consulta con el Programa de Ciencias Oceánicas, debería examinar los posibles beneficios que reportaría la colaboración con el ICSU en este ámbito. El TOWS-WG tomó nota además de la necesidad de conceder mayor atención a las observaciones de los ecosistemas con el fin de apoyar los estudios relativos a las amenazas costeras y los programas de evaluación de la vulnerabilidad y de los efectos de los desastres.

El TOWS-WG tomó nota de las múltiples referencias a la necesidad de disponer de datos batimétricos de alta resolución y de modelos numéricos de elevación, en particular en el Documento Marco del GOWHMS. El TOWS-WG sugiere que el Consejo Ejecutivo examine con urgencia este asunto.

El TOWS-WG señaló que las necesidades en materia de aumento de capacidades rebasaban a menudo el marco del ICG y a veces también de la COI. El diálogo y la coordinación con donantes y contribuyentes potenciales deberían situarse en un nivel elevado, a fin de garantizar la coherencia de los mensajes y las actividades, y optimizar la respuesta. El Grupo de Trabajo podría desempeñar una función al respecto. Asimismo, el TOWS-WG considera que la difusión y el intercambio de información deberían coordinarse

en un nivel elevado, aunque algunas actividades puedan ser específicas de una determinada región.

En general, el TOWS-WG estima que sería oportuno agrupar algunas tareas o traspasarlas a otros órganos de la COI en determinados ámbitos (ciencias, observación, servicios).

El TOWS-WG formuló varias observaciones acerca de la dirección y el funcionamiento de los ICG y señaló varias deficiencias posibles. Ciertos puntos deberían figurar siempre en el orden del día de cada ICG. El TOWS-WG señaló que la interacción entre los ICG y el órgano rector era a veces ineficaz e inoperante. El TOWS-WG pidió al Consejo Ejecutivo que examinara la posibilidad de encargarle el examen de los aportes de los ICG, a fin de simplificarlos y racionalizarlos, de modo que únicamente se sometan los asuntos que requieren una decisión, a fin de que se armonice la labor de la Comisión y se le confiera coherencia.

El TOWS-WG acordó examinar la organización y coordinación de las tareas que realizan los grupos de trabajo de los ICG.

Se examinó la coordinación de la financiación en un nivel elevado, comprendido el apoyo a la Secretaría. Se insistió en la importancia de una planificación estratégica rigurosa y efectiva, una coordinación eficiente y prioridades claras. El Grupo de Trabajo reconoció también las ventajas de la “unidad de acción” en el marco de la COI, por ejemplo, en la colaboración con la Estrategia Internacional de Reducción de Desastres (EIRD) y sus asociados.

РАБОЧЕЕ РЕЗЮМЕ

РГ-СПЦО осуществила обзор работы, проделанной ранее ГСРПЦДОО. Она рассмотрела Рамочный документ и согласилась с его окончательным вариантом.

РГ-СПЦО рассмотрела статус систем предупреждения о цунами и других вспомогательных органов в той мере, в которой он влияет на мандат РГ-СПЦО. Особое внимание было уделено вопросам создания потенциала, обмена информацией и ее распространения.

РГ-СПЦО считает, что для целей предупреждения о цунами и других опасных океанических явлениях СКООМ/ГЛОСС следует определить «основную» глобальную сеть мареографов, по возможности, опираясь на основную сеть ГЛОСС, предназначенную для климатических измерений. РГ-СПЦО считает также, что задачи партнерства в отношении цунамиметров должны перейти к группе действий в рамках СКОММ/ДБКП для использования синергии и выполнения глобальной роли.

РГ-СПЦО считает, что МОК следует утвердить стандарты и одобрить практику работы систем по цунами в целом и что для этого необходимо провести исследование руководящих принципов для региональных и национальных стандартов слежения за цунами. Она также высказалась за публикацию стандартных процедур оценки действий, предпринимаемых региональными и национальными центрами предупреждения о цунами в ходе цунамигенных событий.

РГ-СПЦО отметила некоторые вопросы, касающиеся обмена сейсмическими данными, включая вопросы оперативной совместимости. Двумя факторами являются предоставление данных в режиме реального времени и оптимизация своевременного использования имеющихся решений. РГ-СПЦО предложила создать небольшую целевую группу для изучения этих вопросов и представления доклада ее следующему заседанию.

РГ-СПЦО была проинформирована о ряде сохраняющихся вопросов в области коммуникации. РГ-СПЦО согласилась осуществить анализ потребностей, включая характер доступа к информации ГСТ и вопрос доступа вне НМГС.

РГ-СПЦО отметила, что возможности МОК в отношении опасностей в прибрежной зоне зависят от возможностей ряда первичных и вторичных вспомогательных органов. Она также отметила создание Научной группы МСНС по планированию в ситуациях бедствий, вызванных стихийными опасностями, и согласилась с тем, что вместе с программой наук об океане ей следует опробовать потенциальные преимущества совместной деятельности с МСНС в этой области. РГ-СПЦО далее отметила необходимость уделять более пристальное внимание экосистемным наблюдениям в поддержку исследований опасностей в прибрежных районах наряду с программами оценки уязвимости и ситуации после бедствий.

РГ-СПЦО отметила большое число ссылок на потребность в батиметрических данных с высокой разрешающей способностью и цифровых моделях для проведения оценок, в том числе в Рамочном документе ГСРПЦДОО. РГ-СПЦО предлагает, чтобы Исполнительный совет уделил этому вопросу неотложное внимание.

РГ-СПЦО отметила, что требования, касающиеся создания потенциала, часто выходят за границы МГПК и, подчас, самой МОК. Следует поддерживать на высоком уровне диалог и координацию работы с донорами/финансирующими сторонами, с тем чтобы обеспечить согласованность распространяемых идей и деятельности и получение оптимального отклика. РГ-СПЦО, возможно, способна сыграть в этом свою роль. Аналогичным образом, РГ-СПЦО считает, что существует необходимость

обеспечить высокий уровень координации обмена информацией и ее распространения, пусть даже определенные действия могут иметь региональную специфику.

В целом РГ-СПЦО полагает, что, возможно, настало время укрепить взаимодействие с другими органами МОК или совместно выполнять с ними работу в ряде областей (наука, наблюдения и службы).

РГ-СПЦО сформулировала ряд соображений относительно управления и способа функционирования межправительственных координационных групп, отметив некоторую потенциальную неэффективность. В повестке дня каждой МКГ должен быть ряд постоянных вопросов. РГ-СПЦО отметила, что в ряде случаев взаимодействие между некоторыми МКГ и руководящим органом было формальным и неэффективным. РГ-СПЦО просит Исполнительный совет рассмотреть вопрос о том, чтобы поручить ей проведение обзора вклада международных координационных групп в целях его упорядочения и рационализации таким образом, чтобы вносились только вопросы, требующие решения, чтобы тем самым придать гармоничность работе Комиссии и обеспечить последовательность действий.

РГ-СПЦО пришла к договоренности о проведении обзора организации и координации рабочих групп в рамках международных координационных групп.

Был рассмотрен вопрос координации финансирования на высоком уровне, включая оказание поддержки Секретариату. Было обращено особое внимание на вопросы строгого и эффективного стратегического планирования, эффективной координации и четких приоритетов. РГ-СПЦО также признала очевидное преимущество деятельности в рамках МОК по принципу «единого целого», например, в работе с МСУОБ и ее партнерами.

1. OPENING & WELCOME

Neville Smith opened the meeting. He noted that this is a formally constituted WG of the Executive Council and will report to the upcoming EC and to the 25th Assembly, at which time a decision will be made on its future. The TOWS-WG has a substantial basis arising from the work of the Global Tsunami and other Ocean-related Hazards Early Warning and Mitigation System (GOHWMS) WG.

He further noted that initially, through the GOHWMS WG, the scope was quite general – tsunami, all ocean-related hazards, references to a "system", etc. The TOWS-WG mandate (see Attachment 1) is narrower, focused around sea-level and coastal inundation, and no longer associates the WG with a system (of systems); it does however strongly mandate TOWS to develop a systematic approach.

The Agenda (Attachment 2) was adopted.

The participants are shown at Attachment 3.

2. BACKGROUND

2.1 REVIEW OF THE WORK OF THE GOHWMS

François Gérard reviewed of the work of GOHWMS ad-hoc working group which produced the framework document for global tsunami and other ocean-related hazards early warning systems. He pointed out the need to include all relevant bodies inside IOC (like I-GOOS, JCOMM and IODE) and the UN system (like WMO and ISDR) to ensure synergies and mutual benefit. He also stressed the difficulty to harmonise fully among the existing IOC bodies.

The working group reviewed the Framework document and agreed to modifications based on comments received at the last meeting of the GOHWMS WG, principally from WMO, and changes to reflect recent developments. The final text is included as Attachment 4 to this report.

The TOWS-WG agreed that the Table "Characteristics of Hazards" provided a useful reference for future discussions. A slightly modified version is included here (Table 1) reflecting views of the TOWS-WG, with a view to providing additional updates as the work of the WG matures.

Table 1 : Characteristics of the hazards creating coastal inundation and common topics

MARINE HAZARD	**Tsunami**	**Storm surge**	**Extreme wind-forced waves**	**Long-term sea-level rise**
Likely frequency of event	Decades to millennia, depending on regional tectonic regime	Months to decades, depending on regional climate regime	Months to decades, depending on regional climate regime	On-going, a consequence of global warming and local factors
Type of impact	Catastrophic inundation and drainage surges, perhaps multiple	Catastrophic, single-event inundation	Multiple, localized inundation and drainage surges	Progressive rise of mean high (tidal) water level
Limits of area likely to be affected	Local run-up limit for specified wave amplitudes predicted by modelling	Flood limit for specific surge level and due to upstream riverine flooding due to heavy rain over upper catchment by hydrological modelling	Flood limit for specified wave heights predicted by terrain modelling	Mean high water mark predicted by terrain modelling with allowance for extreme events
Potential warning time	Minutes to hours, depending on proximity of source location	24-48 hours in advance, depending on climatic factors	Hours to days, depending on climatic factors	Decades to centennia
Action by Regional Warning Centre	Issuance of Watches, Advisories and Warnings to National Centres			No action
Action by National Warning Centre(s)	Immediate transmission of Advisories and Warnings to appropriate Local Authorities			No action
Emergency actions by Local Authorities	Stand-by for emergency response action on receipt of Advisory			No action
	Launch of emergency response action on receipt of Warning			
Mitigation by Local and National Authorities and stakeholders	Vulnerability assessment of coastal populations, ecosystems, and infrastructure; Strategic spatial planning and regulation to minimize exposure and vulnerability: Participatory approach; Decision tools and software for analysing hazard loss and risk			
	Public awareness and readiness campaigns, including recognition programmes and emergency response exercises (preparedness) and education (preparedness and adaptation); Promoting community resilience.			

The TOWS-WG also discussed the current status of the actions in the Framework document.

(a) *Coordination of sea-level observations.* This has progress, with agreement that GLOSS will be the focal point. It was noted that INMARSAT is now providing real-time communications. Some further advice is included under agenda Items 3 and 4.

(b) *Seismic observation network.* Has largely progressed as indicated.

(c) *Standards and procedures.* The ICGs and JCOMM have taken this finding on board and progressed actions. Some further considerations are discussed under Items 3 and 4.

(d) *Capacity building.* It was noted that some elements have been actioned within the IOC CB programme of work, such as coastal modelling. It was noted that the ISDR and its UN partners provide a crucial element and that UNDP has been pivotal in developing awareness and preparedness, particular at the country level. This is also picked up in later actions.

(e) *Coastal zone and geohazards.* It was noted that the GEO Tsunami WG has now been dissolved. The TOWS-WG noted that it should work through coastal GOOS and with the ICAM Programme when dealing with coastal zone issues. The GEO Communities of Practice for geohazards, developing from the Theme within IGOS-P provides a convenient communication mechanism in that area. The WG drew attention to the fact that GEBCO should be explicitly actioned with regard to bathymetric data, an issue that remains outstanding.

2.2 TERMS OF REFERENCE FOR TOWS-WG

The WG co-chair reviewed resolution IOC XXIV-14 and the task given to the TOWS WG (see Attachment 1). He stressed that strong links to existing bodies are essential for ensuring issues are implemented in a coordinated way. Some key elements are:

- Harmonisation of reporting and governance arrangements
- Interoperability and efficiency
- Coordination with others
- Advisory to Governing body: no capacity to instruct other subsidiary bodies
- Will have to operate efficiently and remain focused

The WG agreed it was preferable to address a small number of issues well rather than many issues poorly. The TOWS-WG must work with the ICGs and facilitate joined outcomes and avoid division and replication.

The TOWS-WG suggested adding participation of other relevant groups/programmes mentioned in the resolution, in particular ICAM. It also noted the importance of links to the WMO EC Working Group on Disaster Risk Reduction and agreed the finalized Terms of Reference should be provided to the TOWS-WG members when available.

[Action: Secretariat]

2.3 CONTEXT WITHIN IOC AND UNESCO

The co-chair summarized the tasks and work for the TOWS-WG within the framework of UNESCO's 34/C5 and its Main Lines of Action (MLA), including MLA 3 on disaster reduction and

mitigation. This MLA translates to high level objectives HLO 1 - Prevention and reduction of the impacts of natural hazards within the context of the IOC strategic plan. This clearly defines IOC's role and possible contribution on preparedness and outreach material and training on the different levels in the context of and collaboration with other relevant UN bodies.

Particular attention was drawn to the expected results for MLA 3 (HLO 1):

- Risks from tsunamis and other ocean-related hazards reduced through early warning systems and preparedness and mitigation measures
  - Number of regional early warning systems for tsunamis and other ocean-related hazards operational *(4 regional tsunami systems operational or strengthened as part of the global multi-hazard warning system)*
  - Number of preparedness materials produced or communities at risk educated with respect to natural hazards impact prevention, preparedness and mitigation measures (*6 culturally adapted and gender-responsive tsunami preparedness educational materials produced in different languages; 1 community per regional warning system educated*)

3. REVIEW OF ISSUES FROM RELEVANT BODIES

3.1 ISSUES FROM THE PERSPECTIVE OF THE ICGs

Indian and Pacific Ocean Tsunami Early Warning and Mitigation Systems

The TOWS-WG noted a number of findings and recommendations of the recent ICG/PTWS session in Ecuador as well as the ICG/IOTWS in Mombasa.

The summary focussed on issues relevant to the WG mandate. These included a functional website as an essential tool for the PTWS and probably all ICG's. Both sessions also sought clarity on the future function of ITIC. The PTWS and IOTWS sessions recommended addressing ocean data buoys and more generally instrumentation standards on a global level. International workshops could help with that issue. The PTWS offered to "globalize" existing documents and manuals like the user guide or SOPs. Both sessions also noted that global data centres for tsunami related data are required. It was recognized that JCOMM and its subsidiary bodies were already coordinating elements of instrumentation networks.

The WG recognized that work was well advanced within the ICGs in the development of appropriate data and metadata standards for tide gauges and tsunameters, and that actual and potential data and metadata repositories and archival centres had been identified. Nevertheless, there remained a requirement to ensure that this work was properly coordinated across all the ICGs, working through IODE and JCOMM as the appropriate global subsidiary bodies.

Stefanie Dannenmann mentioned that it would be very valuable to have minimum requirements for national plans defined to provide some guidance to MS what should be addressed. KJ Ramesh mentioned that India through INCOIS is constantly improving the instrumentation networks of tide gauges, tsunameters and seismic stations as well as model scenarios based on bathymetric data.

Open data access and IOC data policy has been intensively discussed in both regions. The TOWS-WG agreed that this remains a key issue for regional TWS.

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

Gerassimos Papadopolos summarized the actual situation for ICG/NEAMTWS, its last session in Lisbon and the major decision to establish an ad-hoc Task Team on the regional architecture, which met in February 2008 in Paris. The ICG/NEAMTWS coordination process has been recognized by the European Union's high level commission on disaster risk reduction as the key and leading process to deal with tsunamis and coastal inundation in general.

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

Lorna Inniss, Chairperson of the ICG/CARIBE-EWS, reported that the ICG is quite satisfied with the progress and agreement on data exchange reached so far. She emphasized that the Caribbean group from the very beginning was interested to go for a multi-hazard approach which would include storm surges and hurricanes. She reported that WG 1 has been mandated to look into the requirements for a regional tsunami warning centre as a basis for MS to decide if they can offer such a centre. Barbados is prepared to host a regional TIC supported by ITIC in Hawaii and with strong links to existing Hurricane Information Centres in the region. Thorkild Aarup reported that IOC plans to re-establish up to 19 tsunami-ready tide gauges in the Caribbean with support from different donors like the World Bank and NOAA.

With respect to the plans to upgrade the regional sea-level networks David Green mentioned the need to ensure sustainability of these instrumentation networks. The TOWS-WG agreed that the SIDS meetings should be used more proactively to get TWS issues on their agenda and to investigate possible interaction with the recently established ICSU programme on multi-hazard research.

3.1 OTHER IOC BODIES

Global Ocean Observing System (GOOS)

François Gérard, as Chairman of I-GOOS, reported on the recent decisions and activities in his group and stressed the importance of data access and exchange and mentioned an upcoming initiative with IOC/ABE-LOS to foster data exchange and provide legal instruments for bilateral arrangements between MS. He also emphasized that due to the request of some MS the existing ICG's should be open to take concerns of countries outside the key areas of interest into account.

The TOWS-WG emphasised the central role of GOOS, particularly within a multi-hazard approach. Of particular interest was the potential for GOOS to provide leadership for coastal hazards, both in terms of development of observational infrastructure and in the development of products and services. One example is the challenge of providing total sea level displacement products (predictions) for hazards, combining the effects of tides, surges, coastal flooding and, as appropriate, tsunami. Some coastal predictions systems developed under the Global Ocean Data Assimilation Experiment are addressing this challenge. Another aspect relates to ecosystem observations and coastal hazards.

Disaster mitigation and coastal hazards are now prominent in both the UNESCO and IOC strategies and the GOOS Scientific Steering Committee should consider the implementation of its Coastal GOOS plan within that light.

Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM)

Peter Dexter recalled the role and mandate of JCOMM as a joint coordination body to WMO and IOC. He reported on JCOMM's observations programmes like ocean data buoys and GLOSS. JCOMM's services and data management programme areas cover activities such as storm surges and an ocean data portal. Based on its long history JCOMM is establishing a catalogue of existing standards and best practices, as well as developing new standards for ocean data exchange and management. The need for tsunami related archiving has been mentioned and requires further thought on how best to tackle the issue. KJ Ramesh drew attention to the need for integrating tidal and atmospheric forcing for forecasting the total water level envelope.

Data and Information Management

IODE was not represented at the meeting but a number of related issues were raised by the TOWS-WG, including the telecommunication of data.

One issue which was raised at the 2007 WMO meeting in Bangkok, was how to provide more general and timely access to GTS data, both for NMHSs that presently do not have access to sea level data, and for others who do not have links to the GTS at all.

In principle, the new WMO Information System will have such capability, but the TOWS-WG emphasized that the matter should receive priority. There would appear to be three aspects requiring attention

- Enabling full functionality for those who already have GTS access;
- Enabling access for those not connected to the GTS; and
- Integrating telecommunication systems other than the GTS into the system

3.2 OTHER EXTERNAL BODIES

World Meteorological Organization (WMO)

Peter Dexter reported relevant WMO activities and programmes related to TOWS and explicitly reminded the group to further make use of the GTS/WIS as the backbone communication means for hazard warnings and sea-level data, while the GTS will constantly be upgraded to increase reliability and bandwidth. He emphasised that the WMO Congress gave quite strong support for both the technical work for the marine programme implemented through JCOMM as well as the WMO DRR capacity building activities. The TOWS-WG recommended investigating common capacity building needs of WMO and IOC on how to access tsunami relevant information on GTS and investigate the areas where the GTS still needs to be upgraded to be capable to provide that information. In several cases the national TWFP is not the national Met Service, which requires ensuring the information is forwarded in real time (see also the previous item).

WMO is drafting terms of reference for an Executive Council Working Group on Disaster Risk Reduction and Service Delivery, which will be adopted by the coming EC session.

United Nations International Strategy for Disaster Reduction (ISDR)

Stefanie Dannenmann of UN/ISDR-PPEW, reported on their recent activities in collaboration with IOC and in relation to the ICG-TWS processes. She explicitly mentioned the strong links to IOC e.g. through the Indian Ocean Consortium and more basically through the ISDR system partners approach. In that respect ISDR is mainly acting as a broker between donors and ISDR system partners implementing the overall goal of building an end-to-end TWS.

From her experience with WG6 of the ICG/IOTWS which has received some funding through ISDR, she raised concern on the sustainability of the coordination process when the funding is not available any more.

Tsunami Information Exchange

At the request of the TOWS-WG, the US member of the Group provided an update on the status of the International Tsunami Information Unit (ITIC), in the light of its historic activity and role within IOC and the recent developments in connection with the US Tsunami Act.

At this point the ITIC requires completion of a MOU process between IOC and NOAA to help clarify its contribution to the global tsunami community and to facilitate funding of related programmatic areas. This could result in the need for a new Terms of Reference for the ITIC but also help recognize that the U.S. is proposing to operate the Centre and hosting services for IOC for technology transfer and education as prescribed under U.S. Public Law 109-424 Tsunami Warning and Education Act.

The establishment of an integrated strategy for tsunami information/education, including the development of regional Tsunami Information Centres (TICs), is an important issue in the view of the TOWS WG, and the experience of ITIC provides a significant basis.

4. REVIEW OF REPORTS AND AGREED ACTIONS

In broad terms, the TOWS-WG focused its attention in the following areas, consistent with IOC Resolution XXIV-14:

- Standards for observations
- Data management
- Tele-communication
- Forecast/warning practices
- Capacity building and outreach
- Areas where the TOWS-WG can add value and lead coordination

The aim was to distil a number of actions from the discussions, particular those under Item 3 that would progress the agenda provided to the TOWS-WG. Where appropriate we have noted the likely points for action, but subject to EC endorsement.

4.1 SEA LEVEL TIDE-GAUGE NETWORK FOR TSUNAMI/HAZARDS

As noted previously, GLOSS has been given responsibility for further development of the network, with requirements specified through the ICGs and through other bodies concerned with coastal hazards (e.g., the coastal observation plans of GOOS). The TOWS-WG is fully supportive of this approach, noting that this is an example where the action for individual requirements of bodies has been passed to a body with a broader mandate and specific capability.

The TOWS-WG encourages definition of a global “core” network for tsunami and ocean hazards. It would:

- Build on the existing GLOSS core (for climate) wherever possible;
- Take account of requirements for prediction, detection and post-hazard assessments; and

- Be guided by requirements from Coastal GOOS as well as the tsunami community.

The TOWS-WG agreed that the Caribbean and North African regions should be given priority.

Action point: GLOSS/JCOMM

4.2 DEEP-SEA PRESSURE MEASUREMENTS

These networks are driven almost exclusively by TWS requirements. The TOWS-WG agreed that an action group under the JCOMM/DBCP would be an appropriate long-term home for the current Partnership, noting that this was consistent with the principle of transferring responsibilities out of the individual ICGs to bodies that hold relevant capability as the systems mature and extended beyond single regions. The terms of reference of the Partnership may need modification to be consistent with those of DBCP Action Groups.

Action: JCOMM Chair, International Tsunameter Partnership Chair

4.3 REGIONAL AND NATIONAL TSUNAMI WATCH "STANDARDS"

The TOWS-WG noted the requirement expressed by the ICGs for both the IOTWS and the PTWS for the standardization of formats and procedures for the issue of tsunami alerts and warnings, as well as for the adoption of a standardized approach to post-tsunami event reporting. It agreed that these were both issues where the adoption of common formats and procedures across all the ICGs was essential.

The TOWS-WG noted the potential value to all ICGs of some global guidance on the organization and operation of TWS. Some elements of the draft "Users Guide to the PTWS" and the draft "Regional Tsunami Watch Providers Implementation Plan" for the IOTWS may be of value in developing these guidelines. The TOWS-WG also noted the task team established by the ICG/NEAMTWS and a working group established by the ICG/CARIBE-EWS. There is a need for a process and/or principles to guide all toward a common framework. In some cases, a multi-hazard approach is being taken, whereas in others the focus is just on tsunami. Engagement with JCOMM and WMO is needed.

The TOWS-WG agreed to take on as an action the analysis of the guidelines developed by each ICG, with a view to identifying those characteristics which should be adopted in common, and those where there is not consensus. This action will need to be given priority since the TOWS-WG believes IOC should adopt standards and endorse practices for the tsunami systems as a whole, not individually.

Action point: TOWS-WG.

4.4 SEISMIC DATA

The TOWS-WG was informed of some recent issues associated with the exchange of seismic data and interoperability of information exchange mechanisms (e.g. the recent experience of Peru). The primary requirement is the establishment of a national system, which can then be integrated into regional systems.

With specific reference to the exchange of information on estimates of earthquake magnitude of disturbances, the TOWS-WG noted the following specific points:

- Real time data sharing system
  Relevant seismic data should be shared globally in order to analyze the total

earthquake process/mechanism as best as possible. A standard procedure is needed.

- Use existing solutions provided by other centres as soon as possible
  For any major event centres should concentrate to determine focal parameters and in order to save precious time any focal parameters provided by other (e.g. regional) centres should be used as a basis for the national tsunami warnings.
- Develop a backup/support system among ICGs
  Once a possibly tsunamigenic event occurred the RTWCs will concentrate on monitoring the possible tsunami and updating the information. The RTWCs in other regions could support and provide more detailed information on the earthquake process/mechanism including a real time tsunami simulation based on the detailed analyzed focal mechanism.

The TOWS-WG concluded that a small task team should be established with 1 or 2 participants from each ICG, to correspond on the issues noted above and propose a work plan for seeking resolution.

Action: TOWS-WG

4.5 RTWC AND NTWC OPERATION

Quality controlled parametric data exchange procedure

Quick quality controlled information (human intervention of automatic solutions) on the occurrence of a tsunamigenic earthquake is very useful as initial guidance and reference information for other national tsunami warning centres. A standard procedure shall be developed, perhaps including an ensemble approach.

Develop a standardised procedure to evaluate the actions taken by RTWC and NTWC during a tsunamigenic event.

Continuous progress of the TWS requires learning from actual tsunamigenic events. If we can share the information on action processes during a tsunamigenic event, it will enable to propose modifications to the SOP of RTWC and NTWC. This return of experience process will benefit from a common approach of all ICGs.

Capacity building strategy at National and Regional Tsunami Warning Centres

The quality of information provided by NTWC/RTWC depends on the capacity of the staff at NTWC/RTWC. A joint strategy to build up the capacity is required.

The TOWS-WG supported the publication of standardized procedures to evaluate the action taken by RTWC and NTWC during a tsunamigenic event.

Action: TCU

4.6 IOC APPROACH TO COASTAL HAZARDS

The TOWS-WG noted that IOC capability for coastal hazards resides in a number of primary and secondary subsidiary bodies. GOOS, through its Panel for Integrated Coastal Observations is a lead agent for action, as are the ICGs for modelling of coastal inundation and risk assessment and vulnerability studies. JCOMM has led on storm surge and wave forecasting.

The WG also noted the relevance of the ICAM Programme and other research activities (e.g., in relation to climate change impacts in coastal regions) and the potential for leadership from the Ocean Sciences area, a point that was made by the Report of the Advisory Group for the Ocean Sciences Section (IOC/EC XXXIX).

For the particular requirement of coastal hazard research, the TOWS-WG noted the emergence of the ICSU Scientific Planning Group in Natural Disasters and the potential benefits of working with ICSU because of its access to multi-disciplinary capability and its stated objectives of being user (societal, human impact) driven. It was also noted that the UNESCO Science Programme is actively engaged with ICSU in this area.

The TOWS-WG committed to investigating the potential for engaging ICSU on this aspect, drawing particular attention to the needs of Small Islands Developing States in the Caribbean and South Pacific.

Action: TOWS-WG and Secretariat, in concert with the Ocean Sciences Section.

The TOWS-WG further noted the need for enhanced attention to ecosystem observations to support coastal hazard studies and vulnerability and post-hazard assessment programs. It agreed to bring this need to the attention of GOOS (also see the discussion under the GOOS report for agenda Item 3.1).

Action: IGOOS

4.7 CAPACITY BUILDING AND COASTAL HAZARDS

There was also a related discussion on capacity building, with particular reference to the work of the Capacity Building Programme in support of coastal hazards arising from tsunami.

The TOWS-WG agreed that the needs of small island developing states should be specifically identified, noting statements and decisions of the IOC that specifically related to this issue. It was agreed that there was potential for ISDR and its partner UN bodies to be engaged in such activities, particularly in regard to community responses. This engagement would be best handled on a multi-hazard basis with identification of the specific capability that IOC could bring to such a programme of work as well as the needs that require ISDR involvement.

Action point: IOC CB Programme and Secretariat

4.8 BATHYMETRY

The TOWS-WG noted the many references to the need for high-resolution bathymetric data and digital elevation models, particularly in relation to coastal hazards and tsunami inundation modelling. The issue has been raised at the Executive Council and Assembly, and the International Hydrographic Organization has offered to assist. The IOC co-sponsors and coordinates efforts towards the mapping of the world ocean's floor (e.g. bathymetric charts, geological/geophysical maps), including through the General Bathymetric Chart of the Oceans (GEBCO) initiative. A number of Member States have supported specific actions to improve bathymetric data in the coastal region.

Notwithstanding this work, the TOWS-WG formed the view that the IOC should be encouraging even greater effort, with the ultimate objective of assisting all Member States in obtaining adequate bathymetric data, particularly in relation to coastal hazards. To the extent that it is practical and is contributing to the international effort to mitigate the effects of natural disasters, such data should be made available in line with IOC Data Policy.

Action: TOWS-WG

4.9 TELECOMMUNICATIONS

The TOWS-WG noted there remains a need to establish common practices and protocols for exchanging and accessing information provided through various communication systems.

The TOWS-WG agreed to initially develop a set of requirements, from the perspective of its mandate; that is, spanning all tsunami regions and embracing other hazard requirements, as appropriate. This will include how to access GTS information and the issue of access beyond the NMHSs. This analysis will be provided to WMO through JCOMM.

Action: TOWS-WG and JCOMM

4.10 CAPACITY BUILDING, EDUCATION AND TRAINING

In this case the TOWS-WG is considering aspects (requirements) that transcend at least the boundaries of ICG scope, and usually the boundaries of the IOC itself.

First, it concluded that the Capacity Building Programme should be fully engaged to ensure, first, that solutions are efficient, effective and sustainable within the context of IOC's overall action plan, and second, that the engagement with external partners, particular through ISDR and including joint actions with WMO, is optimised to ensure ISDR and its UN partners see IOC and the ICGs speaking (acting) as one, and that ISDR in turn can optimise its role as a conduit for funding/donor support in response to IOC/ICG needs.

While there may be a case for direct engagement of ISDR/funders at a regional level (e.g., within the context of the Indian Ocean Consortium), general it is more efficient and practical for all parties to focus actions and dialogues at a higher level. Such a strategy will reduce inefficiencies when opening up dialogues with potential funders and reduce the risk of conflicts.

The TOWS-WG noted that it must be prepared to play a lead role in developing a statement of requirement.

Action: TOWS-WG, Capacity Building Program, ISDR

4.11 TSUNAMI AND OTHER HAZARD INFORMATION SOURCES

The TOWS-WG agreed in principle that Tsunami and other hazard information and communication development, such as has been provided through ITIC, should be coordinated at a level spanning all ICGs. While this does not proscribe the creation of regional tsunami information centres, it does suggest that they should be working to a shared strategy and objectives, to avoid duplication and inconsistency, and to introduce efficiencies and enhanced capacity as a whole.

Resolution of the role of ITIC, and other tsunami information units, was needed.

Action: TCU

5. HIGH-LEVEL COORDINATION AND GOVERNANCE

The co-Chairs introduced the item and noted the need for coordination of reporting and interactions with the governing body. While all primary subsidiary bodies like the ICGs are required to report to their governing body, the demand to participate in the Executive Council and Assembly as well as meet normal demands of the ICG can be onerous. Moreover, with four separate reports, and now input (advice) from the TOWS-WG, there is a significant risk of inconsistent decisions and inefficient operation of the governing body. It is within the Member States collective interests, both as members of the ICGs and as Member States of the IOC, to ensure the interactions with the governing body deliver consistent and efficient decision making and that the work of the ICGs is not delayed or hampered by indecision. Acting as one at the level of the IOC has obvious advantages.

The co-Chairs invited views from the Secretariat who are directly impacted by these circumstances. From their perspective, the ICGs should take more direct responsibility for decision making, which in turn implies ICG sessions that are better prepared and clearer in terms of their programme of work, needed resources, and decisions. Clearly streamlining of the information brought to the governing body would be advantageous, particularly if it removed or reduced the risk of ill-informed decisions. With reference to the Terms of Reference of the TOWS-WG, there seemed some potential for the TOWS-WG to assist in making both the reporting and decision making more efficient.

The TOWS-WG drew a number of conclusions.

Modus operandi of ICGs

Quite clearly, the operation of the ICGs is determined by the Rules of Procedure of the IOC and the Resolution of the IOC that created them. It is anticipated that work will continue during intersessional periods, guided by the agreed plans and assisted by the Secretariat, as appropriate. The Chair has an important role, particularly in areas where agreed guidance/decisions are lacking and timely progress is needed. Many primary subsidiary bodies use their elected office bearers as an executive group, to assist and advise the Chair. In other cases, Boards or similar groups have been appointed by the Primary Subsidiary body.

The TOWS-WG noted that the inter-sessional pressures for ICGs are particularly intense since development and implementation is moving rapidly and the Chair is frequently required to approve intersessional and preliminary actions. To the extent that other mechanisms are in place to assist in this approval process, it is important that they are formally agreed and endorsed by the ICGs, with clear terms of reference. It is also important to note that only the Chair is empowered to make decisions and approve actions, and that the Chair is ultimately accountable to the ICG itself. The ICG has primacy.

The TOWS-WG also noted the responsibility of the ICGs for developing and agreeing strategic plans and programmes of work, consistent with the over-arching high-level objectives of the IOC and in-synch with the biennial planning schedule. The ICGs are also responsible for agreeing and coordinating the resources needed to execute the programme of work, and for monitoring progress. In these respects, the TOWS-WG believes it would be advantageous to have standing items on each ICG agenda to ensure proper attention was given to these matters.

Success will be determined by and large by the degree to which the ICGs themselves can mobilise programme resources and additional Secretariat support, and not by the regular programme budget which is generally a small fraction of the total.

Secretariat

To the extent that the work plan requires Secretariat support, the ICGs should provide clear guidance on priority, to guide the Secretariat in its appropriation of regular programme support. Extra-budgetary resources and in-kind contributions can be generated and assigned by the ICG itself, thus facilitating flexibility and degree of autonomy.

Decisions of the Executive Council

Matters related to regular programme budget must be brought to the governing body (Assembly, EC) for decision. The decisions relate to priority and the relative investment against strategic high-level objectives and outcomes, not to the details of the work programme of the Secretariat or to specific allocations.

The formal Reports to the governing body are mostly for noting; the ICGs are empowered to make decisions within their mandate and terms of reference and do not have to have these decisions ratified.

The TOWS-WG noted the intent to harmonise reporting for all primary subsidiary bodies through a common template that would include, among other things, details of progress against the agreed programme and expected results. For the ICGs and their dialogue with external agents like ISDR, it is highly desirable to include a status report for the TWS (that is, progress against the expected result for HLO 1).

In some areas, like the adoption of standards or procedural guidelines it is advantageous to have these agreed at the level of the Governing Body, and to apply them as far as possible to all regions. It is also useful in most instances to have work/links with other bodies of the IOC harmonised through decisions of the Governing Body, in order to avoid multiple lines of engagement on similar topics. In particular where action is required by another subsidiary body, such instruction should be harmonised and coordinated through a decision of the Governing Body, generally taking account of the interests of the ICGs and IOC as a whole.

In principle at least, the TOWS-WG could play a role in this harmonisation and streamlining, acting as a filter for matters brought to the Governing Body.

- The TOWS-WG agreed to seek endorsement from the Executive Council for such a role. At its annual meeting, and prior to the meeting of the Governing Body (see ToR, Attachment 1), the TOWS WG would review the Reports of all ICGS and any other matters being brought to the Governing Body for decision within the mandate and scope of the TOWS-WG. To the extent possible, the input to the Governing Body would be rationalised and streamlined so that only those matters requiring decision were tabled, and in such a way as to harmonise the work of the Commission and introduce consistency.
- To the extent it assisted decision making, the ICGs and other relevant bodies would be invited to talk to particular matters. The TOWS-WG noted the benefits of visibility of the TWS subsidiary bodies and that the role of the TOWS-WG should not interfere with or dilute accountability and ownership of TWS work programmes and associated Reports.

Working Groups

There is a general concern that the creation of Working Groups under each ICG, all dealing with similar matters and often calling on the same capability for advice and input, is not fully efficient. Moreover, where Working Groups are working in similar areas, such as standards,

the terms of reference are often sufficiently different as to lead to different outputs and outcomes, making the task of harmonisation and integration more difficult.

The TOWS-WG agreed that a review of the Work Group arrangements is timely. It recognizes the power accorded to ICGs to create secondary subsidiary bodies and that whatever advice that might be developed is not intended to interfere with this mandate and responsibility. The TOWS-WG will be seeking routes to greater efficiency and effectiveness, for the ICGs, for ocean-related hazard activities more generally, and for the IOC. In particular it will look for:

- Areas where the work can now be, or soon could be undertaken within another subsidiary body with capability and expertise in the area, and able to address the collective (global) needs rather than on a region by region basis. The consolidation of sea level work under GLOSS is an example.
- Areas where the tasks remain specific to tsunami warning but are at a level of maturity where they would be better managed through a single working group spanning all regions rather than several working groups with mandates confined to a particular region. The development of standards is an example where we expect such consolidation.
- Areas where there is a legitimate, on-going need for work specific to a region, but for which there are advantages in having that work harmonised. In this case, the TOWS-WG believes harmonised terms of reference, much as has been achieved for the ICGs themselves, would deliver greater consistency.
- In yet other cases, there may be a requirement for intersessional work. This will be decided on a case-by-case basis by the ICGs themselves.

Mechanisms for collaboration with external communities

There are important interactions beyond the IOC, particularly with the seismic community, with WMO and with ISDR. As is evidenced by the conclusion under Item 4, the TOWS-WG believes this could be more effective if the interactions and communication were largely managed at the level of IOC rather than by the ICGs. This implies an important role of the IOC Secretariat, as well as the TCU, and perhaps also for the TOWS-WG. The conclusions under Item 4 suggest:

- Capacity building and interactions with ISDR should be coordinated through the Capacity Building Program. This does not proscribe initiatives at the regional level and by ICGs, but does suggest the ICGs should avail themselves of the expertise, capability and methodologies established by the CB Programme and contributed to an integrated whole-of-IOC approach. The TOWS-WG believes interactions with ISDR, its partner UN bodies, and other donors and funders would be more effectively managed in this way.
- Observations and services should, to the extent possible and where appropriate be consolidated within those subsidiary bodies with expertise and capability in these areas. This is happening now. It implies a shift to specification of requirements rather than hands-on development and implementation, but not totally. It also implies harmonised engagement with these bodies and integration, and focusing engagement with external bodies like WMO through JCOMM and GOOS.
- Scientific development might also benefit from greater engagement of, and with, the Ocean Sciences Program. The potential is greatest in the area of coastal hazards and the TOWS-WG recognizes that some R&D may be best led by the ICGs (the ICGs are not constrained to deliver outputs only in one area). For coastal hazards generally, external partners may include ICSU and SCOR, WMO/WWRP (for extreme weather and surges), WCRP (for climate-related hazards), IGBP and IUGG.

6. HIGH-LEVEL COORDINATION OF FUNDING

The co-Chairs provided a broad introduction to the issues, many of which were touched on under other items. They again invited Secretariat comment, which focused on:

- The importance of extra-budgetary resources and the impact of UNESCO rules;
- Greater use of regional subsidiary bodies; and
- The creation of special accounts, such as by ICG/CARIBE-EWS.

The TOWS-WG concluded:

- The simplest thing that can be done is to ensure that tsunami and other hazards are effectively represented in the IOC plans, with good indicators of progress toward the expected results, and thus reinforcing and supporting the "business case" for investment in the TOWS-related activities.
- The special accounts have attractions because of their closer relation to the goals of the (regional) activities. However, the attraction for investing in this mode is sometimes dulled by the desire to have more direct control and accountability.
- ICG secretariat and other support should be targeted and focussed on the highest priorities.
- Member State investment in programmes is critical and, in principle, members of the ICGs should be prepared to support their own participation (notwithstanding the broader IOC goals related to WSSD, the MDGs, SIDS, etc.)
- Partnerships and donor relationships work best if we are
    - Acting as one within TOWS scope, and IOC, as we build partnerships, with IOC being accountable for its commitments and being willing to execute its programme in partnerships
    - This is also important for working with ISDR and its UN partners. We are arguing that we should present a single face as far as possible, putting the collective interest ahead of the self interest.
- We have an advantage that we have a good and effective CB&T approach, and that if this can be used more pro-actively, we can both encourage greater and more productive partnerships through ISDR and other mechanisms.
- Being clear on where IOC should lead, and where others have the lead.

7. REPORT TO EXECUTIVE COUNCIL

The report to the Executive Council will include a final GOHWMS Framework Document and the Report from this session of the TOWS-WG.

The focus of the Report will be actions agreed under Item 4 and the suggested approach to governance and funding discussed under Items 5 and 6, respectively.

The TOWS-WG members agreed to circulate an initial draft immediately after the meeting with a view to finalizing the TOWS-WG Report by 18 April. This will allow timely transmission of advice to the members of the Executive Council.

8. OTHER ISSUES

8.1 MEMBERSHIP

With the exception of ICAM Programme representation, the TOWS-WG believes the current membership is appropriate and is not seeking any variation. Chile's membership remains unconfirmed. The co-Chairs noted the difficulty for ICGs to participate fully in this meeting but anticipate less difficulty in the future.

8.2 DATE AND PLACE OF THE NEXT MEETING

It would appear all ICGS will have met at least once more by early April 2009, so the next TOWS-WG meeting will be scheduled for April or early May 2009, noting the proposal for the TOWS-WG to have an explicit role in the transmission of items related to TOWS into the agenda of the Assembly. In this case, some leeway will be required. The place will be Paris unless an effective alternative is identified.

9. CLOSURE OF MEETING

The meeting closed at 15:25 on Friday 4 April.

ANNEX I

AGENDA

1 OPENING AND WELCOME

1.1 OPENING

1.2 ADOPTION OF AGENDA

1.3 WORKING ARRANGEMENTS

2 BACKGROUND

2.1 REVIEW OF WORK OF GOHWMS

2.2 REVIEW RESOLUTION 14 FROM IOC XXIV

2.3 CONTEXT WITHIN IOC/UNESCO

3 REVIEW OF ISSUES FROM RELEVANT BODIES

As per Resolution XXIV-14, for tsunami and sea-level related hazards, to include

- Standards for observations
- Data management
- Communication
- Forecast/warning practices
- Capacity building and outreach
- Areas where body might lead coordination

3.1 ISSUES FROM PERSPECTIVE OF ICGS

3.1.1 Pacific Ocean

3.1.2 Indian Ocean

3.1.3 Caribbean

3.1.4 NE Atlantic and Mediterranean

3.2 OTHER IOC BODIES

3.2.1 I-GOOS

3.2.2 JCOMM

3.2.3 IODE

3.3 OTHER EXTERNAL BODIES

3.3.1 WMO

3.3.2 ISDR

3.3.3 Other

4 REVIEW OF REPORTS

4.1 WELL-DEFINED COMMON CONTRIBUTIONS TO THE GLOBAL SYSTEM OF SYSTEMS
[strengths for which little additional coordination is required]

4.2 GAPS (IN COORDINATION OF COVERAGE), WITH ORDER OF PRIORITY OPPORTUNITIES FOR STRENGTHENED COORDINATION

5 HIGH-LEVEL COORDINATION AND GOVERNANCE FOR TWS

- Coordination of Reporting to the Governing Body
- Adoption of ICG Resolutions
- Acting as one (focal points for coordination)

6 HIGH-LEVEL COORDINATION OF FUNDING

6.1 EXTERNAL INVESTMENT IN TSUNAMI SYSTEMS AND COORDINATION

6.2 FUNDING FOR IOC TOWS ACTIVITIES

6.3 “ACTING AS ONE” WITHIN UNESCO STRATEGY

7 REPORT TO EXECUTIVE COUNCIL

8 OTHER ISSUES

8.1 MEMBERSHIP

8.2 DATE AND PLACE OF THE NEXT MEETING

9 CLOSURE OF MEETING

ANNEX II

TERMS OF REFERENCE OF THE WORKING GROUP ON TSUNAMIS AND OTHER HAZARDS RELATED TO SEA-LEVEL WARNING AND MITIGATION SYSTEMS (TOWS-WG)

Mandate

1. The TOWS-WG will:

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

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

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

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

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

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

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

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

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

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

Membership and modus operandi

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

(a) The Chairpersons of the four ICG-TWSs, and of I-GOOS, JCOMM, IODE

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

(c) High-level representatives invited from the key TOWS-WG stakeholders in disaster risk reduction outside IOC, including WMO and other ISDR System members, FDSN/GSN, and other relevant intergovernmental and international agencies

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

The TOWS-WG shall be chaired by one of the Vice-Chairpersons of IOC and co-chaired by one of the Chairpersons of an IOC Subsidiary Body, on the recommendation of the Chairperson of the Commission after consultations with the IOC Officers.

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

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

ANNEX III

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ANNEX IV

FRAMEWORK FOR THE GLOBAL TSUNAMI AND OTHER OCEAN-RELATED HAZARDS EARLY WARNING SYSTEM

EXECUTIVE SUMMARY

A synopsis is provided of the current capability and status of the tsunami warning and mitigation systems and the multi-hazard and disaster risk reduction needs, in the context of a potential comprehensive, integrated and fully operating global ocean-related hazard warning and mitigation system.

The rationale for IOC leading the development of a global ocean-related hazard warning and mitigation system is presented, building from the four defined tsunami warning systems for the Indian Ocean, Pacific Ocean, Northeast Atlantic and Mediterranean Seas and the Caribbean. The advantages of a multi-hazard approach are exposed, with emphasis on hazards contributing to changes in sea level and coastal inundation. A system of systems concept is outlined, with partnerships with other agencies with responsibilities in this domain. The ultimate objective is a global system of approved specific characteristics and common protocols, and which is operated by adequately trained, equipped and supported national systems for preventing coastal inundation hazards from becoming high impact disasters;

An outline of the characteristics of the hazards contributing to coastal inundation is provided, together with typical actions at the national and regional level and options for mitigation. The elements of a systematic approach are described, including the needs for detection and prediction, data and information management, prevention, and education and capacity building.

The principles underlying a framework are introduced and stakeholder interests are identified in the context of pursuing an end-to-end framework. The proposed way forward is built around the following principles: i) the strengthening of the synergies between the IOC and the other international actors; ii) a simple system of internal governance avoiding creating additional intergovernmental structures; iii) the protection of the user-oriented approach, which is the key to success of the warning systems for the natural hazards.

The necessary observing and decision-making approaches associated with coastal exposure and vulnerability to inundation hazards are introduced with emphasis on harmonisation, standards and good practice. Significant conclusions are drawn in respect of sea-level observations, the coordination of relevant seismic data, the development and agreement of relevant standards (particularly in respect of outputs/services from the system), and coordination capacity building and relevant research.

The approach to governance of such a system of systems are discussed, including a recommendation to create a subsidiary body with responsibility for advising on the development of a system to alleviate the serious risk (directly or indirectly) for human and ecosystem safety, health and sustainability.

Introduction

In response to the devastating tsunami of December 2004, the 23rd Assembly of UNESCO's Intergovernmental Oceanographic Commission (IOC) adopted resolutions formally establishing three Intergovernmental Coordination Groups (ICGs) to co-ordinate the development and operations of three new tsunami early warning and mitigation systems, in the Indian Ocean (IOTWS), the Caribbean and adjacent regions (CARIBE EWS), and the Mediterranean, North-East Atlantic, and Connected Seas (NEAMTWS)[1]. IOC has been mandated, to coordinate the establishment of the Indian Ocean system within a global framework during the course of many international and regional meetings including the World Conference on Disaster Reduction, Kobe, Japan, January 2005 and by the 61st UNGA, Resolution 44. This was based on the IOC's proven experience with the Pacific Ocean Tsunami Warning System (PTWS) initially operated since 1965 through the International Tsunami Coordination Group (ITSU). These decisions were complemented by a resolution[2] establishing an ad-hoc working group for the *Establishment of a Framework for the Global Tsunami and other Ocean-related Hazards Early Warning System (GOHWMS)*.

The ad hoc Working Group (WG) of the GOHWMS held its first meeting during the 39th Session of the IOC Executive Council, Paris, 24 June 2006. It was also during this session that a resolution[3] was adopted, renaming the International Tsunami Co-ordination Group/ITSU as the Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System (ICG/PTWS). The GOHWMS WG was thus in the position to consider development and implementation of a global network of four regional tsunami warning and mitigation systems with associated ICGs, supported by the IOC Secretariat with new roles and responsibilities. The GOHWMS WG meeting was attended by participants from many IOC Members countries, stakeholder organizations including the World Meteorological Organization (WMO), International Strategy for Disaster Reduction (ISDR), and the Group on Earth Observations (GEO) and partner organizations within the IOC including the Intergovernmental Committee for the Global Ocean Observing System (I-GOOS), the Joint IOC/WMO Technical Commission on Oceanography and Marine Meteorology (JCOMM) and the Caribbean regional body (IOCARIBE). The WG provided two documents proposing partnership strategies and identifying benefits and opportunities for integration among the regional and national systems. The WG reviewed regional progress based on presentations solicited from the Chairs of the existing ICGs. The meeting concluded with a recommendation later encompassed in a decision of the 39th IOC-EC, which endorsed the GOHWMS Chair and Working Group and charged them to prepare a *Framework document* for adoption at the 24th IOC Assembly in June 2007.

RATIONALE FOR A GOHWMS

The IOC tsunami warning systems

The IOC is tasked with coordinating the four tsunami warning and mitigation systems through the respective ICGs and with other international agencies and organizations. Currently, the global warning and mitigation system does not constitute a *system of systems* where the regional parts can work together to serve the needs of Member States.

The development of these TWSs derives from a strategy based on a basin-focused approach, in relation with the communities at risk and accounting for regional characteristics[4]. It

1 IOC Resolutions XXIII-12 to 14 respectively.

2 IOC Resolution XXIII-I5

3 IOC Resolution EC-XXXIX.8.

4 A similar approach being developed for the implementation GOOS through regional ocean observing systems (ROOS) co-ordinated by GOOS regional alliances (GRA).

acknowledges unique oceanographic, geophysical, technical, educational, cultural, and political interests. It can also identify and strengthen national systems and existing intergovernmental capacities available for integration into an end-to-end hazard warning and mitigation system. The relevance of the GOHWMS was in defining the conceptual framework for integration and guiding the long term assessment of future requirements serving Member States and organizations. These future needs drive present day strategic investments for operations, development and research, and promote collaboration on priorities and common objectives. The proposed GOHWMS framework will be dynamic and evolve to bridge cross-cutting perspectives of the ICGs and align actions and performance with measured results. This framework will be strategic, discouraging proliferation of too many initiatives with limited resources by promoting near term opportunities, analysis of system attributes and alternatives and optimize mobilization of resources for sustainable advisory and command structures..

All regional tsunami warning and mitigation systems require technical and secretariat support from IOC, other intergovernmental bodies, member states and local organizations. There exists a risk that a proliferation of diverging interests might make the system of systems less efficient. This does not mean that only one organizational body or one worldwide warning center is needed to do the job even if that were possible from a purely technical point of view. Other factors that play a critical role are national and local ownership, pre-existing regional constituencies, competition among stakeholders, capacity building initiatives and overlapping responsibilities.

All the ICGs have formed Working Groups to develop, prioritize and execute plans that advance elements of the end-to-end approach: multi-hazard assessment and modelling, seismic monitoring, sea level and deep ocean observations, data management, warning and information generation and dissemination, preparedness, mitigation, and capacity development. Currently, each working group has drafted or is in the process of drafting action plans. The framework for these actions shall identify common tasks, flow and linkages and align schedules. It shall also promote performance indicators and clarify IOC responsibilities. These lead to agreeing on work plans for each system, based on common standards and targets. Developing synergies amongst regional systems can generate benefits through the use of common standards, access to and adoption of best practices and concepts for sustaining core observation stations and communication channels. Data exchange, warning standards, and dissemination, core objectives and goals should become more achievable and affordable.

Each of the ICGs has recognized the need for integrating national tsunami warning and information dissemination centres into the “optimal” regional concept to meet their current and future requirements. Through building on existing capacities, the ICGs need to take into account civil defense authorities, meteorological services, geo-science ministries, academic institutions, as well as public-private consortia, and many others. Regional centres need to rapidly analyze data and make decisions that minimize impact, generate warning guidance and disseminate information. But because not every country has this capacity or the response system, the framework needs to identify policies, actions, and partnerships that will eliminate barriers and simplify this effort to assess, predict and inform. The framework must elevate the underlying synergies among these organizations including staffing, telecommunications, observational networks and platforms, data processing, response procedures, warning products, dissemination methods, focal points (recipients), operations and maintenance, and outreach and education. Similarly synergies need to be developed among different sub-regions, such as the small island states.

Across all the ICGs there is common agreement to identify best system attributes and effective solutions for data management, robust telecommunications, affordable observing networks, trusted watches and warnings and all efforts to leverage resources ensuring continuity and avoiding duplication. However, there lacks a common mechanism to effectively and efficiently coordinate and subsequently collaborate on the data and information requirements of the stakeholder and user communities activities in a system of systems approach. Thus, all ICGs

would accelerate achievements by intensifying their collaboration in defining criteria for hazard assessment, quality assurance of historical disaster catalogues, data transmission for sea level and seismic monitoring networks, robust and affordable telecommunications, common alerting protocols, and policies that facilitate cost sharing and joint investment. However, in a number of cases ICGs, countries or a group of countries within a region, have been slow in recognizing near-term opportunities such as those related to institutional and structural roles and responsibilities, which focus activities during and after hazard events. In some regions and nations there appears to be a disconnect among organization/ministry responsibility on coastal issues or natural versus man-made hazard issues. Similarly, at the UNESCO/IOC level there appears to be a learning curve on the synergy between science-based organizations and operational entities and the appropriate mid to long-term strategies for action. There are also differing opinions on how synergies between research organizations and operational organizations accelerate the transition of research results, linking observation and measurement with models to assess changes in susceptibility and resilience to coastal flooding in high risk regions and to forecast impacts on coastal populations, ecosystems and living resources. IOC through its members and coordinating groups has the near term opportunity to share data and decision tools for integration, analysis and modelling across the land-sea interface in multiple regions. Specifically, the global efforts can advance the state of coastal predictive models and identify what steps will be needed to enhance community resilience. It is important to recognize that the end-to-end approach of warning, mitigation, and dissemination does not mean everything is compartmentalized or sequential but rather within and across regions interoperability, standards, protocols, and multi-hazard approaches lend to synergistic long term and “people-centred” solutions.

However, knowing what systems could benefit from enhanced integration to achieve the desired outcomes, where they should operate, when they need to perform, how they will be sustained, who are the stakeholders, and why the capabilities of the system fills the regional need are key questions that the framework must answer. IOC’s success in providing global coverage and driving the multi-hazard approach to risk reduction must be augmented by seeking opportunities for developing synergies amongst regional ocean-related hazard warning and mitigation systems.

Towards multi hazard system of systems

The operational concept underlying the global tsunami warning and mitigation system and the strategy to harness synergies across regions contributes to the Global Earth Observing System of Systems (GEOSS). Developing synergies amongst regional hazard systems has underlined the urgent and imperative need for free and open exchange of data among countries and international organizations and the application of improved scientific methodologies and observational information for better decision-making, which are part of the mainstream GEO’s objectives.

The other big issue here is the "multi-hazard approach". Although from the delivery side, early warning for multiple hazards would benefit from integration and a community based approach, we must recognize that except for tsunamis most ocean related hazards which require immediate response are generated by dynamic ocean/air interactions. For such complex coupled systems specialized detection capabilities for measuring and monitoring are needed to readily detect emerging hazard threats. Such specialized detection systems cannot be used as the foundation blocks for a multi-hazard approach. However the supporters for specialized means of detection do not negate the entire concept because other warning system components could benefit from a multi-hazard approach, such as redundancy, reliability, resilience and cost effectiveness of infrastructure in the domains of information and communication technology and an increased level of 24/7 operational readiness and presence. For example, a case can be made for looking at synergistic inundation hazards and high impact events such as tsunami, storm surge, coastal flooding in the multi-hazard multi-sectoral approach. Underlying these hazards are many common observational platforms, databases, and methodologies for

modelling and forecasting threats including alerting protocols such as the Common Alerting Protocol (CAP) and response mechanisms. Integrating some of the related marine hazards has not received much attention and these are in fact extreme manifestation of ocean weather, for which GOOS will generate essential observations to advance risk detection and forecasting processes. Other marine ecosystem hazards are associated with coastal catchments and floodplains, posing risk for human and ecosystem health, directly through exposure to pollutants and pathogens, as well as indirectly e.g., harmful algal blooms. The decisions on how to develop ocean-related multi-hazard strategies either independently or with different stakeholders within the strengthened ISDR System[5] including UNESCO, World Bank, International Federation of Red Cross and Red Crescent Societies (IFRC), UN Development Programme (UNDP), Office for the Coordination on Humanitarian Affairs (OCHA) and WMO. So the coordination process in establishing ocean-wide tsunami and other ocean-related hazards warning systems has been undertaken in close co-ordination and collaboration with the above mentioned UN bodies as well as in cooperation with UNESCO's unit on Natural Disaster Reduction.

In particular there are a number of existing ocean-related hazards warning, mitigation, and dissemination systems that are being coordinated by IOC in partnership with other intergovernmental organizations providing operational and technical input, especially WMO's Disaster Risk Reduction Programme and through JCOMM.

Why a GOHWMS?

The risk of coastal inundation

On the basis of this analysis, we propose defining the initial operational capability of the GOHWMS framework around the early warning and mitigation **of coastal inundation** created by sources including tsunami, tropical and extra-tropical storm surge, and strong swells.. These threats will likely be compounded by global change impacts in coastal systems including accelerated sea-level rise. Significant increases in coastal population and associated activities in coastal catchments and floodplains also lead to rapid and accelerating increases in loads of pollutants and pathogens that pose risk for human and ecosystem health.

This choice is based on the consideration that inundation is the major risk that coastal communities are facing. It accounts the environmental, human and economic increasing pressure to which the coastal areas are subjected. It accounts also the fact that the sustainable development of the coastal communities appears among the Millennium Objectives. Accordingly, establishing the GOHWMS around coastal inundation will be a relevant contribution of IOC and of its partners to these objectives and to those of ISDR.

Such a definition of GOHWMS is to be considered as a first step towards an initial operational capability and a more comprehensive system covering other ocean related risks. We note here risks linked to the "green ocean", such as harmful algal blooms.

The initial focus of the GOHWMS on coastal inundation enables near term opportunities building upon existing systems, existing practices and available knowledge. It also defines coherent scientific, technical, and educational project results. In addition, GOHWMS will contribute to and benefit from the GEO user interface mechanism known as Communities of Practice (CoP) that provide a systematic, targeted, focused and comprehensive engagement of users in the development and implementation of sustained global observing systems. Participation with CoPs concerned with geophysical hazards and integrated coastal area management will ensure that providers of data and information are involved and cooperate on specific high priority challenges facing disaster prevention and mitigation in coastal regions.

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5 ISDR System and the Global Platform for Disaster Risk Reduction, through UN Resolutions 60/195 and 61/198 http://www.unisdr.org/eng/about_isdr/basic_docs/GA-resolution/a-res-61-198-eng.pdf

A structuring approach

Storm surges, strong swells and currents, resulting from atmospheric forcing phenomena, in principle may be predicted and detected with adequate lead time to generate effective warning guidance and to notify at-risk communities, since the forcing phenomena (tropical cyclones and storms) can be characterized and modelled. Tsunamis are a consequence of seismic, volcanic or geological hazards. In the current state of knowledge, these hazards are not foreseeable or predictable, but they are detectable. Early detection involves integrated data (observations) from seismic networks and arrays of deep ocean sensors and sea level gauges. Combined with propagation and digital elevation models, based on availability of adequate bathymetric and topographic data, site-specific forecasts of tsunami impacts and higher resolution regional warnings are becoming available. This is the main distinction from more traditional meteorological warning and mitigation systems, which has effects on the forecast and therefore warning chain, as summarised below:

a) The forecast of the inundation related to storm surges or swells falls under the regular process of meteorologic and oceanographic event forecasting. The timely generation of guidance, dissemination of warnings and information, and the notification of emergency mangers, authorities and the public spans days to hours preceding the impact. The detection, warning, forecast, notification and education process is usually executed under the authority of a national hydrometeorological service (NHMS) and in some cases by oceanographic, naval or civil defense agencies. The intergovernmental organisations, IOC and WMO, through their intergovernmental subsidiary body JCOMM, coordinate, develop and recommend standards and procedures for a fully integrated marine observing, data management and services system that uses state-of-art technologies and capabilities.

b) The forecast of the inundation related to tsunamis depends on the rapid detection of the forcing phenomena (earthquake, volcanic eruption, landslide), verification of the wave generation (deep sea and sea level data), and on the analysis of its tsunamigenic character. Detection initiates a first warning of an inundation hazard, that can be cancelled if no tsunami is detected. In the opposite case, one enters a deterministic process of forecast and warning for distant tsunami. But, if the tsunami is local, a different process has to be activated. These are the attributes that characterise the concept of operations and standard operating procedures developed for tsunami warning services in the Pacific Ocean system (PTWS). It remains to establish interoperable operations and services elsewhere. It is the current work of the IOC and of its partners, in particular the WMO, but more especially the communities of oceanographers, meteorologists, geophysicists and seismologists, emergency and coastal zone managers to address cross-cutting issues and ensure interoperability.

The table 1 below gives an illustration on the above and highlights what is common to the four identified marine hazards forcing a coastal inundation.

MARINE HAZARD	**Tsunami**	**Storm surge**	**Extreme wind-forced waves**	**Long-term sea-level rise**
Likely frequency of event	Decades to millennia, depending on regional tectonic regime	Months to decades, depending on regional climate regime	Months to decades, depending on regional climate regime	On-going, a consequence of global warming and local factors
Type of impact	Catastrophic inundation and drainage surges, perhaps multiple	Catastrophic, single-event inundation	Multiple, localized inundation and drainage surges	Progressive rise of mean high (tidal) water level
Limits of area likely to be affected	Local run-up limit for specified wave amplitudes predicted by modelling	Flood limit for specified surge level predicted by terrain modelling	Flood limit for specified wave heights predicted by terrain modelling	Mean high water mark predicted by terrain modelling with allowance for extreme events
Potential warning time	Minutes to hours, depending on proximity of source location	Hours to days, depending on climatic factors	Hours to days, depending on climatic factors	Decades to centennia
Action by Regional Warning Centre	Issuance of Watches, Advisories and Warnings to National Centres			No action
Action by National Warning Centre(s)	Immediate transmission of Advisories and Warnings to appropriate Local Authorities			No action
Emergency actions by Local Authorities	Stand-by for emergency response action on receipt of Advisory			No action
	Launch of emergency response action on receipt of Warning			
Mitigation by Local and National Authorities and stakeholders	Vulnerability assessment of coastal populations, ecosystems, and infrastructure; Strategic spatial planning and regulation to minimize exposure and vulnerability: Participatory approach; Decision tools and software for analysing hazard loss and risk			
	Public awareness and readiness campaigns, including recognition programmes and emergency response exercises (preparedness) and education (preparedness and adaptation); Promoting community resilience.			

Table 2 : Characteristics of the hazards creating coastal inundation and common topics (Courtesy R. Arthurton – WG4 of NEAMTWS)

This being explained, we will focus on the coastal inundation, which makes it possible to identify common topics allowing to define the technical and institutional framework of the GOHWMS: detection, forecasting, warning, notification, education and training related to sea level abnormal variations. The framework will provide the strategic focus for data providers and users to identify

necessary observing and decision-making approaches associated with coastal vulnerability to inundation.

a) **Detection:** The warning system includes real-time monitoring (remote and in situ measurements) for the detection of the instantaneous high-impact events, long-term tracking of abnormal variations of the sea level, and archiving of historical events. This includes seismic (land and ocean bottom) for detection and sea level verification (deep ocean tsunameters and real-time tide gauges). It is essential for the verification of a tsunami besides the detection of tsunamigenic earthquakes by networks to assess and confirm changes for forecasting the potential impacts. It is necessary for the inundation (tsunami wave, storm surge, etc) as validating data for models and studies of susceptibility and reslience to coastal flooding in high risk regions. Detection is fundamental to initiate planning for data integration, analysis and modeling across the land-surface interface to understand links between hazards and climatic variability. The corresponding tool is a global sea level observation system providing the ocean monitoring and prediction capability for sea level changes and related research. Elements of this observation system exist as GLOSS within JCOMM under the framework of GOOS, and must be adapted to meet the requirements of the GOHWMS and the needs of the user community. The GOHWMS must also promote integration with the seismic network of the Comprehensive Test Ban Treaty Organisation (CTBTO), the Federation of Digital Seimograph Networks (FDSN) and the Global Seismic Network (GSN) among others. In general, IOC and WMO ocean observing systems are implemented and maintained in conformity with technical regulations, standards and best practices developed under JCOMM for operation in national Meteorological and Oceanographic Services.

b) **Forecast:** Tsunamis and storm surges involve waves of long wavelength and forecasts can be made for high impact disasters at the land-sea interface. Magnitude and timescales for these events are substantially different depending on velocity and depth of the wave energy. A fundamental difference, assuming both events reach the same elevation is, in general the flow velocities in a tsunami tend to be much higher and can be associated with geophysical deformation. In a storm surge flow velocities are associated with surface wind waves propagating inland on top of the surge, and decrease in force and elevation as they move down from the sea surface. In the case of a tsunami, a water current 1 m in depth is still capable of considerable structural damage. Tsunamis which manifest as a rapidly rising sea level which come inland, and then recedes, may have lower velocities. The simulation and forecast models in both cases rely on accurate bathymetric and topographic data and digital elevation models. The commonalities in propagation models and the linkage to ocean and coastal models provides opportunities for exploiting synergy. It is possible that the implementation of these models may be available in the same or complementary forecast centres, benefiting meteorological, marine, and navigational services and leveraging expertise and experience to improve data availability and effectiveness of mulithazard forecasts. Elements of this forecast system for tropical cyclones, storm surges, wind waves, sea-level rise and coastal flooding exist in several WMO Programmes and its Technical Commissions, including the joint WMO/IOC Commission JCOMM.

c) **Data and Information Management:** Requirements of the user groups: real-time responders, near-term post event builders, and longer-term planners, policy makers, researchers and eduators present a challenge for data and information exchange and mangement. Coastal inundation necessitates the real-time collection and timely dissemination of meteorological and sea level data, to which the seismic data is assimilated for the analysis of tsunamis and related hazards. Downstream, the dissemination of the warnings for the notification of emergency managers, authorities, and the public in a position to make critical decisions and take actions to save lives and property has to be carried out in an efficient and effective way. There are also requirements that the incoming and outgoing data and information be secure and archived. The development and use of standard data exchange, management and

assimilation processes for data integration, analysis, modeling, communication and stewardship as well as common alerting protocols for dissemination of information and warnings is key to achieving measurable benefits from the GOHWMS.

d) **Prevention:** The development of the risk prevention plans for coastal inundation, of the warning plans and of the corresponding rescue plans necessitates the preliminary knowledge of the submersible areas. The corresponding tools are **models of coastal inundation** needing to have **adapted bathymetric databases** and making it possible to evaluate and predict the transition through the coast line.

e) **Education:** The essential element of the success of inundation disaster prevention and mitigation is the education and capacity building that promotes resilient communities. Training of system operators, responders, policy makers and the public in this end-to-end multihazard system must be strengthened to ensure effectiveness, continuity and sustainability. Ultimately the training must include outreach to the public and community leaders making critical real-time decisions so that lives are saved and economies protected for all global communities at risk.

THE FRAMEWORK OF THE GOHWMS

1. Principles

What we reviewed in the previous paragraphs makes it possible to propose a framework of development for the integrated system of warning and prevention of the coastal inundation caused by the Ocean. The proposed way forward is built around the following main principles: i) the strengthening of the synergies between the IOC and the other international actors; ii) a simple system of internal governance avoiding creating additional intergovernmental structures; iii) the protection of the user-oriented approach, which is the key to success of the warning systems for the natural hazards.

It is excluded that the GOHWMS be thought or be presented as a centralised system dedicated to the risk of coastal inundation. A regional definition of the systems, close to the users, essential for the oceanic phenomena with coastal repercussions dependent on the local conditions, must be preserved. It is the fruitful step followed by the IOC for its tsunami warning systems and by the WMO for the tropical cyclones, storm surges and wind waves warning systems. At this point in time one must intervene to avoid parallel developments leading to redundancies and economic losses.

The perspective is to identify the common problems to the regional warning systems and to propose the relevant organization GOHWMS will work, inventing new systems only in the event of noted lack. The creation of an additional level of management will therefore be avoided by building upon existing programmes and groups already established by the stakeholders.

In summary, starting from the individual problem of the tsunamis, each ICG has to work only on the configuration of the system adapted to its region, and to coordinate its implementation. The ICG is therefore the authority defining the various elements of the system (observation, telecommunications, warnings). These specifications will have then to be analysed to identify what is specific and what can be entrusted to existing groups. It is at this level that the GOHWMS intervenes, to propose the guidelines. The GOHWMS will provide standards, develop common procedures and processes and include existing competent groups. WMO Congress noted and supported ongoing priority areas identified by JCOMM, including support for marine multi-hazard warning systems, within the context of the WMO priority area of disaster prevention and mitigation. Congress recognized that many of these areas could only be implemented through full and active cooperation and coordination between WMO and IOC. This coordination should commence initially with the IOC-ICG/IOTWS because needs for long term maintenance, data management and archiving have been articulated clearly by Members in that region.

2. Stakeholders

The attached schematic and table provides a first attempt at capturing the role and mandates of different stakeholders involved in various aspects of GOHWMS, in order to develop a system, roles and responsibilities and exiting operational capacities available through networks of different agencies. The initial stakeholders of the GOHWMS are IOC, WMO, ISDR, GEOSS and their subsidiary bodies, which cover the main part of the needs of the forecasts and warning system, and entities representing the seismic networks for what concerns the tsunami originating hazards.

a) **IOC:** The Intergovernmental Oceanographical Commission (IOC) is mandated by the United Nations to define and coordinate the development and the implementation of the tsunami warning systems, with a view to inserting them in an overall multi-hazard system, the GOHWMS in question here. Within the IOC, this action is entrusted currently to four Intergovernmental Co-ordination Groups (ICG) responsible for four oceanic basins. The other programmes of IOC, GOOS for the observation, IODE for the data management, ICAM for the integrated management of the coastal areas, and Capacity building have the capacity and mandate to contribute to the GOHWMS. In the Joint IOC/WMO Technical Commission for Oceanography and Marine Meteorology issues of common responsibility are being addressed.

(b) **WMO:** The World Meteorological Organisation, in particular through seven of its programmes, contributes directly and substantially to different aspects of GOHWMS: Marine Meteorology and Oceanography Programme, Tropical Cyclone Programme, Hydrology and Water Resource Programme, World Weather Watch Programme, Disaster Risk Reduction Programmes, Space Programme and Education and Training Programme.

(c) **ISDR:** The International Strategy for Disaster Reduction (ISDR) is the programme of the UN with the responsibility of preparing the human communities to protect themselves against the risks, by presenting vigilance vis-a-vis the risks like an integral component of sustainable development, with the objective of reducing the economic, environmental and human impact due to natural and industrial risks. It has with its asset the Hyogo Declaration (January 2005), the organisation of conferences on early warning and the adoption of pilot projects on the matter. The ISDR establishing the link with NGOs active in prevention and the management of the disasters is therefore an essential partner of the GOHWS, in particular in the fields of education and of the preparedness of communities at risk.

(d) **GEOSS:** The Global Earth Observation System of Systems (GEOSS), established in February 2005, has for its prime societal objective the prevention of the natural risks. The GOHWMS appears as such in the relevant part of the GEOSS work programme for 2007-2009, and the next ministerial meeting, in November 2007, expects results on the matter. In addition, the User Interface Committee defined the concept of Communities of Practices, making it possible to make all the participants working around a given subject to work together. A Community of Practice relating to the geohazards and coastal zone was therefore created, which will aid development of the GOHWMS.

These are the principal organisations which can help in the development and the implementation of the early warning systems to the risks of coastal inundation. For tsunamis, which have a geophysical origin, it will also be necessary to work cooperatively with the international bodies representing the CTBTO International Monitoring System IMS and the research seismic networks including FDSN, GSN and national systems.

3. Harmonisation, standardisation and practices

The harmonisation, standardisation, the exchange of information and the promotion of the best practices are the first elements of the GOHWMS. Structures to do so exist within IOC, WMO and their subsidiary bodies and programmes. It remains to work with the geophysicists' community and, in this area, the use of GEO can prove fundamental, without forgetting the bottom-up approach arising from the setting up of the TWS.

The GOHWMS at its start must build from two existing observation systems functioning on a global scale, the sea level observation system and the seismic observation systems.

The sea level observation system has to be truly global, in the sense that it covers the ocean, the regional seas and the coasts, by using unified methods and standards allowing in particular the real time collection of the data. The majority of the elements of this network exist. The sea level observation system includes a network of deep ocean bottom pressure moorings for detecting tsunami signatures. Standards need to be closely coordinated with GLOSS and the Data Buoy Cooperation Panel under JCOMM. These groups were established to serve the needs of various project issues like climate change, study of tides, tsunami warnings, calibration of the satellite altimeters, etc.

- The international coordination of the sea level observation system dedicated to the risks should be entrusted to GLOSS, under the joint responsibility of IGOOS for planning and JCOMM for the implementation. This may force to re-examine the GLOSS mandate, but it is imperative to have an integrated approach of all observations of the sea level.

The seismic observation system adapted to the GOHWMS, functioning in real time, remains to be developed with the relevant communities and their international bodies. It is a current process within the framework of the definition of the TWS, but the responsibility for the IOC is to ensure overall consistency of it, in particular through the corresponding tasks identified in the GEOSS work programme for 2007–2009

- The IOC shall, with the appropriate international partners, work to define the relevant seismic observation network for tsunami warning which could then be incorporated into existing global seismic networks. Relevant arrangements with CTBTO are in place. This task appears explicitly in the 2007-2009 work programme of GEOSS (DI-06-02), which provides the framework of this action by associating the various communities in charge of the problem, in particular IGOS-P.

The national weather services are centres of forecast and issuing warning for the storm surges and high swells. TWS have put or are setting up national tsunami warning centres, which are often hosted by weather services. It is therefore useful to consider their convergence in the long term towards single centres of warning to the coastal inundation, provided that it is relevant to the local conditions.

Effective working relationships including the exchange of information between all warning centres responsible for forecast and warning of coastal inundation hazards must be coordinated to ensure convergence and optimization of sustainable methods and practices. The JCOMM already carries out this exchange within the framework of its services programme area concerning the marine multihazards including storm surges and strong swells. All programmes of the IOC play a role in training, education and outreach for establishing tsunami warning capabilities. The global network profits ad interim from the ongoing international tsunami warning and forecast services provided by the PTWS, especially the US Pacific Tsunami Warning Center (PTWC), the Japan Meteorological Agency (JMA), the US West Coast/Alaska Tsunami Warning Center (ATWC), and by the WMO through its network of National Hydro-Meteorological Services

(NHMS) within the framework of the tropical cyclone programme. This includes finally the joint organization of forecast and warnings associating all the actors.

- The IOC/WMO JCOMM and IOC's tsunami programme will initiate comparison of the standards for operation and standard operational procedures used in the information and warning systems that they coordinate. This must lead to the identification of the attributes for effective warning and mitigation systems and to recommendations on the requirements for interoperability among warning centres in the regions and across regions. This should include areas of responsibility covered by the existing centres and address roles and responsibilities in areas with inadequate services. The WMO Disaster Risk Reduction Programme and the ISDR will be associated with this process. One initial action shall be to define a common vocabulary/glossary related to the warning systems.

4. External communication and development of capacities

The GOHWMS has common objectives with the existing regional systems, which covers preparedness and the mitigation of the coastal inundation hazard through education and outreach. Education products are critically important to harmonising and sustaining effective ocean-related hazard warning and mitigation programs. How the GOHWMS moves forward on regional and global communication relies on greater efficiencies in developing and distributing communication and educational materials. This includes publishing news letters and guidance documents as well as hosting web sites. Joint coordination and support of intergovernmental hazard prevention and disaster risk reduction web sites enhances a common look and feel important for greater usability and extensibility. Joint "ownership" also promotes accessibility and ensures the context is correct and up-to date. This is especially important to have a GOHWMS strategy for posting critical information immediately following a high impact event including soliciting feedback from the general public. Sharing of material and practices has therefore to be envisaged, within the long term framework of the Capacity Building strategy of UNESCO's IOC, WMO and other members of the ISDR System.

- The IOC will incorporate a programme concerning the GOHWMS into its Capacity Building Strategy, based on the requests of the ICGs and of the IOC/WMO JCOMM and the Commision for Hydrology of WMO. It will incorporate initially aspects: building local capacity and leadership through the oceanographic, seismologic, meteorological and hydrological communities and providing training for Tsunami Warning Focal Points (TWFP) with emphasis on operators' training. **This programme will be developed jointly with the WMO and the ISDR.**

5. Research and development

Research and development in support of the GOHWMS concerns mainly three subjects: detection (observation systems), prevention (preparation of the plans) and the forecast (propagation models). As detection and forecast are accounted above, focus shall be given to the prevention, which requires continuous effort of coastal modelling, which cannot be conducted by IOC only.

- The IOC will work with the GEO coastal zone and geohazards communities of practice to define the framework for enabling increased access to coastal bathymetry and promoting coastal inundation-related mapping and modeling projects.

6. Organization within the IOC

Existing bodies

The organisation of the GOHWMS by the IOC appears explicitly in the work plan of GEOSS for 2007-2009, adopted in November 2006, through two tasks. The DI-06-04 task devoted to the global tsunami warning system, the results of which are awaited for the GEO meeting at ministerial level, in November 2007. The DI-06-08 task is devoted to the multi-risk approach. The proposals below can provide a reply to the questions raised by these two tasks.

To manage the development of the GOHWMS within the framework defined above, it is not necessary to create new intergovernmental bodies within the IOC. The existing groups and committees, the qualified entities of the secretariat, correctly connected, are the tools of it. First, there are the primary subsidiary bodies of the IOC which can be involved to differing degree in the GOHWMS.

a) Four ICG-TWS (Pacific, Indian, Caribbean, the NE Atlantic and Mediterranean). They have all in their mandate to supporting cross-cutting goals of IOC and make the connection among themselves, and, integrate with ocean-related hazards and observation systems, and for the Caribbean system with related multi-hazard systems. At their disposal are the ITIC and the already identified warning centres (PTWC, WC/ATWC and JMA).

b) I-GOOS and its scientific steering committee, the GSSC, which works with the network of regional alliances (GRA), their systems and their needs, to define and develop GOOS in direct link with the usesrs, amongst them, the TWS.

c) JCOMM, the Joint Technical Commission of IOC and WMO. It has JCOMMOPS; the structure of information and of coordination on the implementation of the in situ networks. It is tasked with the coordination of the practices as regards observation and oceanic services, the latter point being central to the development of the GOHWMS. It is therefore the JCOMM, which will establish the practical link with the relevant programmes of the WMO.

d) IODE, which controls projects like ODIN and developed tools like Ocean Teacher, of direct use to the development of the GOHWMS.

e) IOC/ABE-LOS, expert advisory group on the Law of the Sea, an aspect which is not to be neglected when one is concerned about prevention of the coastal risks.

The five regional subsidiary bodies of the IOC (IOCARIBE, IOCEA, IOCINDIO, IOCWIO and WESTPAC), which represent the interests of Member States of the IOC in a given region, and have therefore capacity of initiative as regards to warning systems may also play a role in the system. Let us note on this subject that the ICG/CARIBE-EWS develops, with clear support and linkages with IOCARIBE and that WESTPAC is at the origin of some GOOS regional alliances (GRA).

The IOC has therefore the structures able to support the development of the GOHMS. It remains to organise their joint work.

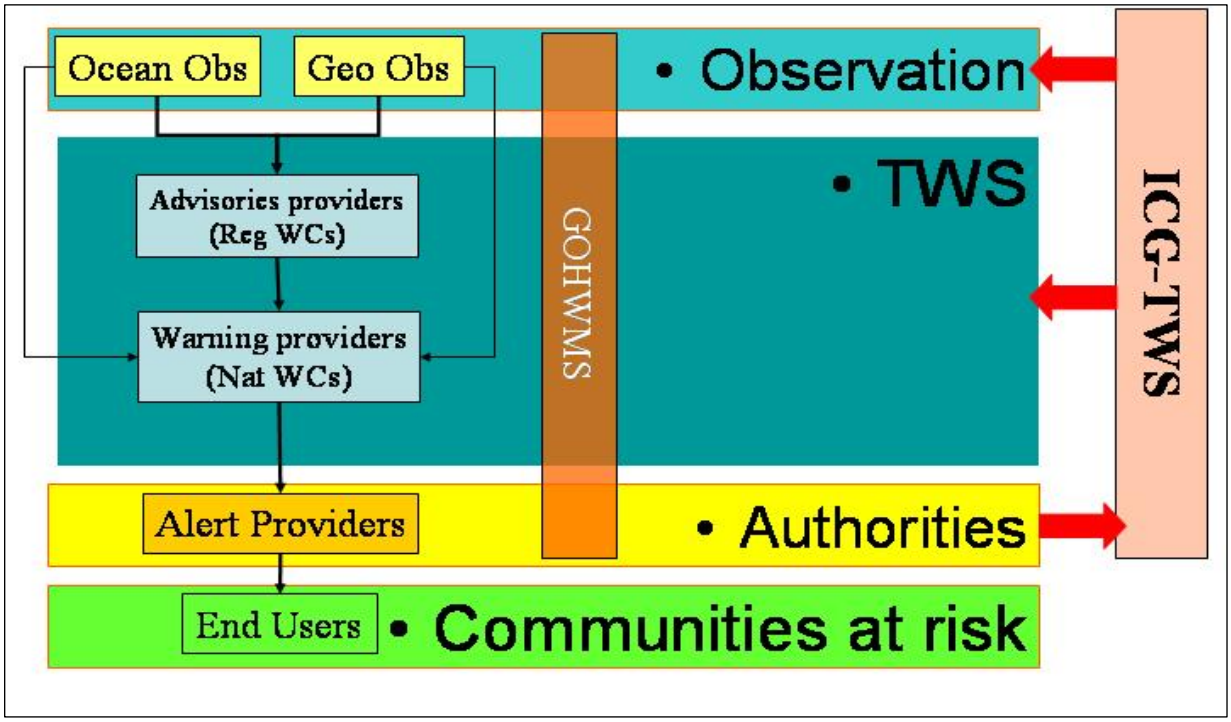

Figure 1 : The topics covered by GOHWMS and by the ICGs in relation to the information chain (on the left).

An IOC Executive Council Working Group

The sections above described the tasks in the context of GOHWMS (see also figure 1) and listed the entities and stakeholders involved in its implementation. We examine now a governance mechanism within IOC, to oversee the coordinated and integrated approach to tsunamis and other hazards related to sea-level warning and mitigation systems.

The main IOC players are seven primary subsidiary bodies of IOC: the four ICG/TWS, I-GOOS, JCOMM and IODE. Since these bodies report to the IOC Governing body, the co-ordination has to be ensured at the executive level of IOC, namely the Executive Council. Therefore:

- A co-ordinating body shall be established on tsunamis and other hazards related to sea-level warning and mitigation systems, as a Working Group of the Executive Council.

IOC Resolution XXIV-14 established a Working Group on Tsunamis and other hazards related to sea-level Warning and mitigation Systems (TOWS-WG). The mandate agreed in that resolution asked the TOWS-WG to:

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

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

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

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

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

b) Report to the IOC Executive Council and Assembly on these common activities and propose new actions, as required.

c) Advise the IOC Executive Council and Assembly regarding:

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

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

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

ANNEX V

LIST OF ACRONYMS

CAP	Common Alerting Protocol
CARIBE-EWS	Tsunami and other Coastal Hazards Warning System for the Caribbean and Adjacent Regions
CoP	Communities of Practice
CTBTO	Comprehensive Test Ban Treaty Organisation
DBCP	Data Buoy Cooperation Panel
DRR	WMO Disaster Risk Reduction
GEBCO	General Bathymetric Chart of the Oceans
GEO	Group on Earth Observations
GEOSS	Global Earth Observation System of Systems
GLOSS	Global Sea-Level Observing System
GOOS	Global Ocean Observing System
GOWHMS	ad hoc Working Group for Global Tsunami and Other Ocean-related Hazards Early Warning System
GTS	Global Telecommunication System
HLO	UNESCO High Level Objective
ICAM	Integrated Coastal Area Management Programme
ICG	Intergovernmental Coordination Group
ICSU	International Council for Science
IFRC	International Federation of Red Cross and Red Crescent Societies ()
IGBP	International Geosphere-Biosphere Programme
INCOIS	Indian National Centre for Ocean Information Services
INMARSAT	Formerly: International Mobile Satellite Organization
IODE	IOC International Oceanographic Data and Information Exchange
ISDR	Un International Strategy for Disaster Reduction
ITIC	International Tsunami Information Centre
ITSU	International Coordination Group for the Tsunami Warning System in the Pacific (superseded by PTWS)
IUGG	International Union of Geodesy and Geophysics
JCOMM	WMO-IOC Joint Technical Commission for Oceanography and Marine Meteorology
MDG	United Nations Millennium Development Goals
MLA	main line of action

NEAMTWS	Tsunami Early Warning and Mitigation System in the North-Eastern Atlantic, the Mediterranean and Connected Seas
NMHS	WMO National Meteorological and Hydrological Service
NTWC	National Tsunami Warning Center
OCHA	Office for the Coordination on Humanitarian Affairs ()
PPEW	Platform for the Promotion of Early Warning
PTWS	Pacific Tsunami Warning and Mitigation System (formerly ITSU)
RTWC	Regional Tsunami Warning Centre
SIDS	Small Island Developing States
TCU	Tsunami Coordination Unit
TOWS	Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems
TWFP	Tsunami Warning Focal Point
TWS	Tsunami Warning System
UNDP	UN Development Programme
UNGA	United Nations General Assembly
WG	Working Group
WIS	WMO Information System
WMO	World Meteorological Organization
WSSD	World Summit on Sustainable Development
WWRP	WMO World Weather Research Programme

In this Series, entitled

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

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

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

121. IOC/WESTPAC Co-ordinating Committee for the North-East Asian Regional Global Ocean Observing System (NEAR-GOOS), Second Session,

Thailand, 1997

122. First Session of the IOC-IUCN-NOAA *Ad hoc* Consultative Meeting on Large Marine Ecosystems (LME), France, 1997

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

167. First GOOS Users' Forum, 2000

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

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

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

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

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

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

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

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

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

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

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

179. *Cancelled*

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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