Intergovernmental Oceanographic Commission
Reports of Governing and Major Subsidiary Bodies

Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System

Twenty-first Session

Melbourne, Australia
3–5 May 2006

UNESCO

Intergovernmental Oceanographic Commission
Reports of Governing and Major Subsidiary Bodies

Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System

Twenty-first Session

Melbourne, Australia
3–5 May 2006

UNESCO 2007

IOC/ICG-PTWS-XXI/3
Honolulu, 1 May 2007
Original: English[1]

Working Documents / Summaries available at PTWS-XXI web site:
http://ioc3.unesco.org/ptws/21/index.htm

Abstract

The Twenty-first Session of the Intergovernmental Coordination Group for the Tsunami Warning and Mitigation System in the Pacific (ICG/PTWS) was held in Melbourne, Australia, 3–5 May 2006 under the Chairmanship of Captain Rodrigo Nuñez. The ICG was attended by 45 participants from sixteen ICG/PTWS Member States, 10 participants from non-PTWS Member States, representatives from six organizations, and 12 observers. The Session reviewed progress made during the inter-sessional period from October 2005 to April 2006 and drafted its work plan for the period 2006–2007. This work plan will focus on (i) continued support for the International Tsunami Information Centre (ITIC); (ii) the conduct and assessment of a Pacific-wide Tsunami Warning exercise 16–17 May 2006; (iii) support for the continued work of the inter-sessional Working Groups, and the development of a Medium Term Strategy; (iv) completion and assessment of the Assessment Questionnaire for ICG/PTWS Member States in support of PTWS capacity building; (v) completion of the Integrated Tsunami Data Base (ITDB); (vi) support for development of the TsunamiTeacher, and for translations into French and Spanish; and (vii) support for Working Groups on the Central America Pacific Coast Tsunami Warning System (CAPC-TWS) and the Southwest Pacific; (viii) support for enhanced TWS capacity in the South China Sea region. The five inter-sessional Working Groups on (i) seismic measurements, data collection and exchange; (ii) sea level measurements, data collection and exchange; (iii) tsunami hazard identification and characterization, including modelling, prediction and scenario development; (iv) resilience building and emergency management; and (v) interoperability of regional, sub-regional and national Tsunami Warning and Mitigation Systems in the Pacific each met immediately prior to the Twenty-first Session and provided the Group with a summary of activities to date and recommendations for further work. Working Group Two on sea level measurements, data collection and exchange met jointly with the similar working group of the ICG/IOTWS to synergize and coordinate its activities across adjacent ocean basins. The ICG requested a budget of US$ 168,000 for the biennium 2006–2007 to accomplish the work plan; noted that only US$ 58,000 is presently funded, and that Member States will provide approximately US$ 1,290,000 in Extra-budgetary Support. The ICG also decided to form an inter-sessional Task Team to review the PTWC proposed tsunami bulletin language changes, consider additional changes, and solicit input from all Member States on the potential impact of the bulletin amendments in accordance with USA NWS standards. Moreover, as a consequence of the Tonga earthquake 4 May 2006 the ICG acknowledged the need for continued improvements to the timeliness and clarity of messages and other communications. The Exercise Pacific Wave 06 will be the first Pacific-wide exercise and the post-event feedback received from Member States will guide the ICG/PTWS in the planning and format of future exercises. The ICG urged the small island nations in the Pacific and Caribbean regions to exchange experiences on hazard warning and mitigation, and encouraged participation in future ICG meetings. Furthermore, the ICG encouraged Pacific Island Countries to join IOC and ICG/PTWS if they have not already done so. The ICG expressed its support for the establishment of a framework for a global tsunami and other ocean-related hazards early warning system, and acknowledged the importance of the partnerships ICG/PTWS presently has with the IUGG Tsunami Commission, the World Data Center-A, GLOSS, WMO, JCOMM, ISDR and regional organizations such as SOPAC. In this regard the ICG/PTWS will continue to look for opportunities to improve the effectiveness of the Tsunami Warning System through existing or new partnerships. In support of other newly established Tsunami Warning Systems the ICG/PTWS will request the IOC Tsunami Unit in Paris to produce a tsunami newsletter covering global tsunami issues and news. The ICG decided to organize its Twenty-second Session in October 2007 and accepted the offer of Ecuador to host the Twenty-second Session. The ICG further accepted the offer of Samoa to host the Twenty-third Session in 2009. The ICG again recommended that on the occasion of the next election of officers, to elect two Vice-Chairmen, following the example of ICG/IOTWS.

[1] An executive summary of this report is also available in English, French, Russian and Spanish.

TABLE OF CONTENTS

page

page

ANNEXES

1. OPENING

1 The Twenty-First Session of the Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System was held in Melbourne, Australia, from 3 to 5 May 2007 under the Chairmanship of Captain Rodrigo Nuñez.

2 The Group was addressed by the Chairman of the ICG/PTWS. Captain Nuñez thanked the distinguished delegates of the 28 Member States for attending, and for their efforts to contribute to the continued development of the Pacific Tsunami Warning System. He emphasized that the PTWS is an effective and coordinated network of regional, sub-regional and national systems covering the Pacific Ocean and all of the attached seas. The full version of the Captain Nuñez's speech is available in Annex III.

3 The Group was addressed by Dr Geoffrey Love, Director of Meteorology, Australian Bureau of Meteorology, on behalf of the government of Australia. He recognized the good work of the Local Organizing committee. He welcomed the Group to Melbourne. Dr Love noted that the 2004 Indian Ocean tsunami has presented us with an opportunity to work together, with the support of governments, to increase our capacity for data exchange and to build an effective and enduring tsunami warning system. The full version of the Dr Love's speech is available in Annex III.

4 The Group was addressed by Dr Neville Smith, IOC Vice President, on behalf of Dr Patricio Bernal, Executive Secretary IOC. The full version of the Dr Bernal's speech is available in Annex III.

5 In his welcome, Dr Bernal commended the leadership of the ICG/PTWS for sharing its experiences with the other oceans over the last two years. He noted that "Exercise Pacific Wave 06" is only a few days away. This exercise will focus on the two components of the system: the evaluation and issuance of warning messages by the designated warning centres to the national tsunami focal points, and the national and/or local response and warning dissemination and communication mechanisms once a warning is received. He mentioned that the exercise is capturing the attention of the world-press as they anticipate and assess the readiness of the countries around the Pacific to react to the announcement of the arrival of a destructive Pacific-wide tsunami upon their shores.

6 He cited the PTWS as an example in which successful international cooperation has built the global detection networks and the communication channels that guarantee timely issuance of the international messages. Globally, he described the remarkable progress in the Indian Ocean since 2004 in building a warning system, and in the Mediterranean and North Atlantic and the Caribbean where there is commitment to stand up systems in the next few years. Dr. Bernal noted, however, that while the momentum for establishing a global system is there, the only new resources that the IOC has received to finance these activities have been earmarked for the Indian Ocean. There is a need to integrate the regional systems more, to use the synergies and make them truly multi-hazard, and for this, more international coordination and accordingly, more support is needed. He highlighted the importance of IOC Resolution XXIII-15 establishing an ad hoc Working Group to provide a global early warning framework for global tsunami and other ocean-related hazards.

7 Dr Bernal asked the Group to take note of the challenges that we face. We need to ensure that the investments in tsunami detection networks under IOC, essential for the "upstream flow" of data necessary to issue a "tsunami watch" or warning, are accompanied by a parallel long-term investment securing the "downstream flow" of the information from the warning centres to the people at risk. To do this, we need to improve national engagement to secure the "last mile", getting the warning to the people at risk, and to have the plans at hand so everybody knows what to do in the case of an emergency. He recognized the ISDR and WMO as partners with the IOC in the end-to-end tsunami system globally and in addressing early warning in a multi-hazard, sustainable context, as they have been for the IOTWS.

8 In closing, Dr. Bernal recalled the words he began his speech with – recognizing the PTWS's enthusiasm and commitment over the decades in undertaking the task of tsunami early warning in the Pacific based on its belief that science and technology can save lives, and its courage to take on the huge responsibility that has required full cooperation and trust, transparency and accountability. He thanked this community of practicing professionals for building a System that is reliable, effective and now responsive and responsible for challenging itself to review, identify gaps, and strengthen weaknesses.

2. ORGANISATION OF THE SESSION

2.1 Adoption of the Agenda

9 The Chair recalled that Paragraph 404 of the ICG/ITSU-XX Summary Report recommended having a second Vice-Chair from a small country that has not yet established a national tsunami warning system. He reported that the recommendation was discussed by the Officers and forwarded for consultation to the IOC Headquarters. He further noted that the Technical Secretary reported that the procedures for the election of Officers to Subsidiary Bodies cannot limit the nominations of only certain Member States, and therefore the recommendation cannot be enforced. Nevertheless, the Officers encourage Member States to consider nominating candidates from countries in early stages of system development.

10 The Chair informed the Group that the Technical Secretary will request the IOC Executive Secretary to send Member States a Circular Letter asking for nominations. Elections of the PTWS Chair, and two Vice-Chairs will be held at ICG/PTWS-XXII.

11 **The Group adopted** the Agenda (Annex I, hereto) and Timetable (Doc IOC/PTWS-XXI/1 Add. Prov).

12 **The Group agreed** to proceed with the election of two Vice-Chairmen at ICG/PTWS-XXII.

2.2 Designation of the Rapporteur

13 **The Group decided** to designate Mr Brian Yanagi from the ITIC as the Rapporteur for the meeting, and **agreed** that input to the Summary Report of the Session will be the responsibility of the Chairman, Vice-Chairman, Technical Secretary and participants introducing each Agenda item. The Technical Secretary will organize the completion of the Summary Report in coordination with the Rapporteur and Chairman.

2.3 Session Timetable and Documentation

14 The Chair introduced the Session Timetable and informed the Group that all working documents will be available through the PTWS web site http://ioc3.unesco.org/ptws/21/index.htm for consultation and downloading. He asked the Group to refer to the PTWS-XXI Annotated Agenda (Doc IOC/PTWS-XXI 2 prov.) as this would provide guidance for discussions during the Session.

15 The Technical Secretariat reminded the Group that in order to enable the Group to endorse, recommend and/or decide on matters, the Chairs should draft PTWS Recommendations, in the IOC standard format, for distribution to Member States. The Recommendations would then be discussed and acted upon by the Group during Agenda item 15.

16 The List of Participants is presented in Annex V.

2.4 Local Arrangements

17 The Chair of the Local Organising Committee, Dr. Peter Dexter, informed participants of local arrangements.

2.5 Establishment of Sessional Working Groups

18 **The Group established** three intra-sessional working groups to work on (i) Programme and Budget 2006–2007 for review and update based on the mid-sessional status under Agenda item 13 (Chaired by Canada); (ii) Medium Term Strategy for the PTWS under Agenda item 5.3 (Chaired by PTWS Chair); and (iii) Southwest Pacific tsunami warning and mitigation under Agenda item 4.3.

3. PROGRESS IN PROGRAMME IMPLEMENTATION

3.1 Report of the Chairman on Inter-sessional Activities

19 The Chair provided a summary of the activities of the PTWS from October 2005 to April 2006 (IOC PTWS-XXI/6). As most of the activities planned at ITSU-XX are still in progress, or part of inter-sessional working groups, the Chair deferred the reporting of progress to the Working Group Chairs under the relevant Agenda items. Since no IOC Executive Council or Assembly has taken place since ITSU-XX, both ITSU-XX and PTWS-XXI will be reported on to the 39th Session of the IOC Executive Council in 21-28 June 2006.

20 He indicated that the priority of PTWS-XXI is to examine and identify all actions that must be carried out to improve/implement an efficient, rapid and accurate Pacific Tsunami Warning and Mitigation System. These actions should be derived from the analysis and discussion of the Working Group findings. He recalled the new terms of reference of the ICG/PTWS, noting the creation of other Intergovernmental Coordination Groups for tsunami warning and mitigation, and called for PTWS Member States to consider the new role of the PTWS in relation to other systems.

21 The Chair recognized the importance of the Pacific-wide tsunami exercise planned for 16-17 May 2006 as it should be used to improve the communication plan and to identify weaknesses and gaps in the Pacific Tsunami and Mitigation Warning System on all geographical scales. The need for a timely and accurate assessment of the exercise by each Member State is important. The results of the exercise will be analysed by the Task Team, PTWC, and PTWS Officers, and a preliminary report will be available for the 39th Session of the IOC Executive Council in June 2006. The final report will be presented to the 24th Session of the IOC General Assembly in June, 2007.

22 The Chair further recommended that the Group consider yearly exercises or a second exercise before PTWS-XXII.

23 He reported that the PTWS Vice-Chairman attended the second meeting of the Indian Ocean Tsunami Warning and Mitigation System, held in Hyderabad, India 14-16 December 2005. It had been agreed that, if possible, the Chairman will attend meetings held in South and Central America and the Vice-Chairman other regions of the Pacific Ocean.

24 The Chair expressed strong concern that the allocated PTWS budget is insufficient for a sustainable PTWS, especially as the establishment of other tsunami warning systems have reduced the available funding to PTWS.

25 The Chairman encouraged Member States to contribute to the IOC Trust Fund in support of the PTWS-XXI Work Plan implementation and to approach their governments and IOC representatives for more staff and budget for the national and international tsunami warning and mitigation program. He asked that requests be made at the IOC-EC and then followed up to the UNESCO General Assembly. He reiterated that currently only very limited financial support is given

by IOC to the most important operational programme of IOC, and the only IOC programme with the direct goal of saving lives.

26 He noted the important role played by the ITIC in providing assistance to PTWS Member States, but also that the ITIC has been requested by IOC Headquarters. He called for Member States of the PTWS to strongly consider bolstering the ITIC through secondments to ITIC, in-kind support, regional Associate Directors, and other means.

27 In closing, the Chairman invited IOC Member States who are not yet part of ICG/PTWS to join the Group and contribute to the activities of the PTWS. He noted that the ITIC is ready to help these countries with the paperwork required by IOC to become members. He further invited countries who are not IOC Member States to also be part of IOC and the PTWS.

28 The Chairman recalled that an effective tsunami (early) warning system must be in place in the Pacific Ocean to respond appropriately, and in a timely manner, upon recognition that a potentially destructive tsunami is coming. He noted that it has taken forty-one years to achieve this objective, but added that this is a continuous process that requires the permanent involvement of governments, institutions, organizations and people working in tsunami programs. He stated that the key to achieve and keep the effectiveness of a tsunami warning system is to develop and maintain close cooperation at all levels - from the international, national, regional, and institutional down to the local level. He emphasised to always remember the safety of coastal populations, and to continually seek to reduce response time, improve the exchange of data and information with our neighbours, develop and deploy better instruments, enable better computational tools, establish better planning tools, develop better educational aids, and take on other proactive mitigative measures.

29 **The Group congratulated** its Chairman for his attention to the programme's needs and **accepted** his report on inter-sessional activities.

3.2 National Reports

30 Through Circular Letter No. 2188 of 17 March 2006, Member States had been invited to attend the ICG/PTWS-XXI, and were also requested to submit National Reports not later than 7 April 2006, so as to provide participants sufficient time to read the reports.

31 The Chairman reported that twenty-two (out of 28 ICG/PTWS Member States) National Reports had been made available through the IOC/PTWS-XXI web site (http://ioc3.unesco.org/ptws/21/PTWS-XXI_working_documents.htm). The Chairman expressed his satisfaction with the number of reports submitted for this Session, stating that this was the highest number ever.

32 The Chairman requested Member States to provide brief statements, as necessary, on important issues, proposals to improve the TWSP and national needs, and referred the Group to the National Reports under Documents IOC/PTWS-XXI/7 for details.

33 The Delegate of Australia presented highlights of Australia's Tsunami Warning System developments, referring to Document IOC/PTWS-XXI/7.16. The Australian system is operated by three technical agencies; the Bureau of Meteorology, Geoscience Australia, and Emergency Management Australia. These agencies are supported by AusAID and the Department of Foreign Affairs and Trade to assist with international capacity building in the Indian Ocean and Southwest Pacific in particular. Australia is hosting this ICG/PTWS-XXI in Melbourne. In addition, Australia hosted a Pacific Island Countries (PIC) Training Workshop in Melbourne just prior to the Session. Australian agencies are increasing their seismometer and sea level networks and are planning for real-time transmission of additional data, especially in the SW Pacific, over the next year. A seismometer has been installed on Christmas Island in the Indian Ocean and another one will be installed on Norfolk Island by the end of the year.

34 The Delegate from Japan informed the Group about two tsunami events that occurred around Japan since the Twentieth Session. He referred to Document IOC/PTWS-XXI/7.2 for further information. The Japan Meteorological Agency (JMA) issued a tsunami forecast for the M7.2 Torishima earthquake off the east coast of the mainland of Japan on 14 November 2005. JMA issued the forecast of "Tsunami Attention", which is for an estimated amplitude of 0.5m or less. A small tsunami, up to 42cm, was observed in Ofunato on the east coast of Japan. The other event occurred on New Years Day of 2006. A very small tsunami was observed at several sites in Japan. The tsunami was generated by an earthquake near Torishima Island, which is located due south of Izu Islands. The earthquake was not large (M5.9), but the historical record shows that some earthquakes of around M6 have generated tsunami in this area. JMA carefully monitored sea level observation data at that time and fortunately, the tsunami did not reach the criteria for calling attention to the public.

35 Japan stressed the importance of sea level monitoring, referring to the Torishima event. In this respect and on the basis of discussions at the Twentieth Session of the ICG/PTWS, Japan reported that it will transmit sea level data from 5 Japanese tide stations to PTWC every 15 minutes with 1-minute sampling rate. This is planned to start by May 2006.

36 The Delegate of Canada referred to its National Report available as Document IOC/PTWS-XXI/7.8. At ICG/PTWS-XX, Canada agreed to transmit Canadian sea level data by GOES to be available to the WC/ATWC. Data from four stations, three of which support monitoring for tsunami warning operations, is being transmitted by GOES and has been accessed by WC/ATWC since April 2006.

37 He confirmed that $25,000 (Canadian) has been sent to the IOC, earmarked for the Tsunami Trust Fund for use by the PTWS as reported in the Programme of Work and Budget for 2006-2007 of PTWS-XX. He hoped that an additional contribution of $10,000 (Canadian) will be made to the Tsunami Trust Fund (PTWS) during the upcoming inter-sessional period.

38 The Delegate from New Zealand reported that its delegation includes all its key stakeholders in its official tsunami warning and mitigation process. They are the Ministry of Civil Defence & Emergency Management (MCDEM), Land Information New Zealand (LINZ), GNS Science-GeoNet, and the National Institute of Water and Atmospheric Research (NIWA). He referred to Document IOC/PTWS-XXI/7.13 for further details.

39 Recent developments and current work include the completion of two key reports identifying and describing New Zealand’s risk of tsunami and its preparedness to deal with that risk (available at http://www.mcdem.govt.nz), the implementation of a tsunami detection and warning system based on seismic stations and strategically placed sea level gauges, identification of improvements and an implementation plan to its existing system of sea level gauges to improve its ability to detect and monitor tsunamis, establishment with Australia of common data standards and stations of joint interest, adoption of a new National Civil Defence Emergency Management Plan effective on 1 June 2006 describing the arrangements for emergency management (including for tsunami) in New Zealand, launching of a comprehensive multi-media public education programme with all hazards approach emphasising preparedness, and complementary benchmark research to understand current national levels of awareness, understanding and preparedness.

40 Finally, he reported that New Zealand will be participating on a large scale in the up-coming Exercise Pacific Wave 06. All of their regional and local authorities will participate, as well as all key stakeholder agencies at the national level.

41 The Delegate of France informed that he, with the High Commissariat Cabinet Director and the Director of the Civil Defence Department in French Polynesia, the Director of the Civil Defence Department in New Caledonia and, for the last 20 years, the CEA/LDG/CPPT Director, formed the French Delegation. He referred to Document IOC/PTWS-XXI/7.9 for further details.

42 He informed that there is an additional Tsunami Focal Point for France, the Director of the Civil Defense Department in New Caledonia, where a programme on tsunami warning and mitigation has started as part of the French Tsunami warning and mitigation programmein the Pacific and part of the Pacific Tsunami Warning System. He further stated that the three components of the tsunami warning and mitigation system are considered to include hazard assessment, preparedness, and the warning (which is their priority in 2006 and 2007). Sirens, operated by High-Commissariat Departments located in Tahiti, will be implemented in each inhabited island in French Polynesia. Solar backup power is to be planned, with independent local transmission and receipt using Inmarsat mini-C Satellite receivers. The first sirens were implemented recently in the five Australs archipelago Islands. The six Marquesas Islands will be equipped before July 2006. The 60 French Polynesia inhabited islands will be equipped before 2008.

43 The Delegate from the United States referred to Document IOC/PTWS-XXI/7.17 for details. He summarized that in the United States (US) the Tsunami Warning System (TWS) is operated by the National Oceanic & Atmospheric Administration's (NOAA) National Weather Service (NWS). NOAA's National Ocean Service (NOS) is primarily responsible for the maintenance of US coastal sea level gauges in the TWS. Tsunami research is conducted by NOAA's Environmental Research Laboratories and by various universities under the direction of the National Science Foundation (NSF). The World Data Center (WDC) for Solid Earth Geophysics, including tsunamis, is operated by NOAA's National Environmental Satellite, Data & Information Service's (NESDIS) National Geophysical Data Center (NGDC). NESDIS also supports the TWS by providing communications from remote data platforms through NOAA's Geostationary Operational Environmental Satellite (GOES). The Japan Meteorological Agency (JMA) provides support to the TWS by the use of its Geostationary Meteorological Satellite (GMS) to transmit data from US sea level stations in the westernmost Pacific. The US Geological Survey (USGS) is responsible for seismological research and their National Earthquake Information Center (NEIC) assists the TWS through the provision of real-time seismic data and by cooperation and collaboration on other aspects of seismic data collection and analysis. The US also continues to host the International Tsunami Information Centre (ITIC), as it has since the Centre's inception in 1965, by providing personnel and administrative support for the Centre to carry out its mission in support of the Pacific Tsunami Warning and Mitigation System.

44 He reported that the US is working with the ICG/PTWS and all other ICGs. Highlights of this work are the upgrade of the US TWC in Hawaii and Alaska with staffing to operate 24/7 as of 26 April 2006, continued expansion of monitoring systems and DART buoys including 32 DART buoys in the Pacific Ocean by March 2008, upgrade of 33 sea level stations (20 completed to date), expansion of seismic networks in Alaska and Hawaii with real-time broadband stations, improvement on the use of modelling and simulation to provide operational forecasts models of tsunamigenic events, expansion of NOAA's capabilities in gathering of datasets, historical datasets and helping with hazard assessments, emphasis on building tsunami resiliency by building upon the Tsunami Ready Program, and quality-control and archival of observations from the greatest tsunami historical events in its catalogue.

45 He additionally reported that the US is collecting and making available sea level data, DART data, other monitoring data, and bathymetric and topographic data. However, he noted concern the need to consider a plan for the long term archiving of sea level data and a mechanism or facility that will enable these data streams to be made available to the entire community.

46 The Delegate from Fiji referred to Document IOC/PTWS-XXI/7.20 for details. He reported that Fiji is continuing its tsunami awareness and outreach programme. To date, it has reached 212 coastal villages and coastal schools.

47 The Delegate from the Republic of Korea referred to IOC/PTWS-XXI/7.19 for details. He reported the establishment of the One Stop Earthquake and Tsunami Analysing and Broadcasting

System in 2005. The system disseminates warning messages, including fax, email, and SMS, etc. and it is still being improved and developed. The goal of the system is to issue warnings within five minutes of an event. Korea will install an ocean bottom seismometer by the end of 2006. The Republic of Korea is currently sending seismic data to JMA from five stations of the Korea Meteorological Agency (KMA) and receiving data from 22 stations of JMA. It is keen to share seismic data with other countries.

48 The Republic of Korea reported that it has contributed $1000 per year to the PTWS Trust Fund since 2001.

49 The Delegate from the Russian Federation reported on the achievements since ICG/PTWS-XX, referring details to Document IOC/PTWS-XXI/7.3. He reported that a national programme was developed under the Federal Target Programme: *"Decrease of risk and the mitigation of consequences of emergency situations of natural and technogenic character in the Russian Federation till 2010"*.

50 He reported that Programme Actions include the development of the seismological network and the means of data processing and transmission for the tsunami warning system, the reconstruction and modernization of the sea level observation network (17 stations planned) in order to ensure the reliability of the information about tsunami threat, the construction of an Inter-regional Center at Petropavlovsk-Kamchatka for the data collection and tsunami warning, the modernization of the Tsunami Warning Centres (TWC) at Yuzhno-Sakhalinsk and Vladivostok on the basis of modern data processing technologies, the introduction of modern communication technologies for data collection and information exchange, and the development of operative automated information data exchange between the TWCs and the State/Regional authorities.

51 The Delegate from China reported that in 2005, China announced the National Contingency Plan for tsunami, storm surge and sea ice. Subsequent to the announcement of the national plan, some coastal provinces have devised provincial tsunami contingency plans. He referred to Document IOC/PTWS-XXI/7.15 for details. To support public awareness, China has translated the ITIC booklet, "Tsunami – The Great Waves" into Chinese. The booklet and poster in both Simplified Chinese and Traditional Chinese versions will be published soon with support of the National Marine Environment Forecasting Center of the State Oceanic Administration and the Hong Kong Observatory.

52 He reported that Hong Kong Observatory has been providing real-time tide gauge data to JMA and PTWC for tsunami monitoring since 2005. Further, a key research programme on tsunami warning technology is included in the national 11th five-year science and technology programme which starts in 2006. Finally, a seminar for ASEAN (Association of Southeast Asian Nations) marine disaster warning will be held in Kunming, Yunnan Province, China, in summer 2006.

53 The Delegate from Malaysia presented its progress in the implementation of a people-centred Tsunami Early Warning System, referring to Document IOC/PTWS-XXI/7.5 for details. Significant improvements have been made to the monitoring component. The seismic network has been enhanced with the installation of two new stations with broadband sensors and two of the existing short period stations have been upgraded with broadband sensors. Malaysia is contributing near real-time seismic data from seven broadband seismic stations for regional and international exchange. Two tsunami buoys have been deployed in the surrounding seas, one north of Sumatra Island and the other in the South China Sea. A network of four coastal cameras has been installed on the north-western coast and six tide gauges are under installation at strategic locations.

54 In its on-going efforts to strengthen the nation's earthquake and tsunami early warning system, Malaysia co-hosted with IOC an International Round Table Dialogue on Earthquake and Tsunami Risk in Southeast Asia and the South China Sea that was held in Kuala Lumpur on 27-28 April 2006. The Joint Statement and Action Plan of the Roundtable is provided in Annex VII. To improve knowledge and skills in tsunami numerical modeling in the region for disaster mitigation, Malaysia is

hosting the UNESCO-IOC International Training Course on Tsunami Numerical Modelling organized by ITIC in Kuala Lumpur from 8-19 May 2006 (http://ioc3.unesco.org/ptws/21/working_groups_other_tsunami_meetings.htm)

55 The ITIC Director reported on behalf of the government of the Philippines. She thanked the Philippines for the hosting of a tsunami training workshop in November 2005. The Philippines hosted a training workshop for tsunami modelling in November 2005 that was attended by participants from developing countries in the Indian Ocean, Southeast Asia, and some Pacific countries. The training workshop was funded by ITIC and IASPEI with PHIVOLCS providing the venue, logistics, local transportation support and lodging facilities at its main office in Quezon City. The training workshop was designed to teach basic skills to participants to enable them to initiate run-up and inundation modelling. It is expected that their new experience and skills will help enhance their countries' tsunami hazard and risk mapping capabilities. The ITIC Director also reported that the Philippines will participate in the Pacific-wide drill at the local level in Albay Province. To that extent, she reported that the IOC ITIC and the UN development Programme (UNDP) are working together to support Indian Ocean observers from Indonesia, Sri Lanka, and the Maldives.

56 The Delegate from the Cook Islands reported that his country became a member of the IOC in January 2006, although the Cook Islands have previously been an informal member of the ICG/PTWS for a number of years. He reported that the Tsunami Warning Focal Point is the Meteorological Service, as well as the airport authority because of the GTS link. For the Exercise Pacific Wave 06, he reported that they have met twice with stakeholders and will take part in the exercise.

57 **The Group congratulated** Member States on their national reports and **agreed** that the progress reports are all very encouraging, particularly regarding the reported increases in data sharing between member countries. There also has been increased coordination and cooperation between all countries in the region. With these developments, it was hoped that in the near future sub-regional centres may be able to be established.

58 The Chair noted that the PTWC is only able to deliver Pacific-wide information on tsunamis and watches. There is also an important need for a system for local and regional tsunamis for tsunamis that attack coasts within an hour, in order to provide alerts in time for countries to process information and disseminate public safety actions. This can only be accomplished, if at the sub-regional level, we have good coordination, and if we have a centre(s) committed to integrate all the information and disseminate the alerts.

3.3 ITIC Director's Report

59 This Agenda Item was presented by the ITIC Director, who provided an overview of the activities of her Centre during the inter-sessional period. Her Report is provided as Document IOC/PTWS-XXI/8

60 During the Inter-sessional Period, the ITIC continued to strongly support the efforts of the IOC Tsunami Programme, especially in the Indian Ocean, as the lead Centre for sharing experience and know-how, based on the Pacific, with regions starting to implement tsunami warning and mitigation systems in the world's oceans and marginal seas. The ITIC Director attended a total of 15 meetings between October 2005 and April 2006.

61 The ITIC Director provided an overview of the PTWS system which is based on the strong commitment and contributions of national systems. National Tsunami Coordination Committees should be comprised, at the very least, of the warning centres responsible for event detection, forecast, and warnings, the emergency organizations responsible for public safety and preparedness, and the science organizations requested by government to be responsible for hazard identification and risk assessment. She emphasized the achievement of a seamless end-to-end system, from international,

sub-regional, or national hazard detection, to multi-media, redundant, understandable alerts, to local awareness and if needed, immediate evacuation of people on a beach.

62 To identify potential gaps, she informed the Group on the high value of the National Assessments, recalling that the 135-question Questionnaire had its beginnings in 2004 with the SOPAC-ITSU South Pacific Tsunami Awareness Workshop. She informed the Group that the Questionnaire had been used to conduct 16 assessment missions in the Indian Ocean in 2005 in cooperation with the WMO and ISDR, and using experts in tsunamis, communications and preparedness. She reminded the Group that the Pacific Questionnaire had been distributed for completion for ITSU-XX, but that only nine countries had returned the Questionnaire.

63 She encouraged Member States to strongly consider conducting National Capacity Assessments, either as a first step to developing a tsunami warning and mitigation system, or as a means of regularly evaluating progress, and offered the assistance of the ITIC or the PTWS Secretariat wherever it might be needed. Because of the travel costs involved, she agreed that nearby regional experts would be one way to help reduce costs. She indicated that Australia was considering such a proposal that could assist Pacific Island Countries.

64 The ITIC Director informed the Group on the PTWS activities the Centre participated in partnership with other agencies. These included continuing to facilitate the merging of the two existing databases of the NOAA National Geophysical Data Center and the Novosibirsk Tsunami Laboratory into a single high-quality, verified database with original referencing as recommended by the Group at PTWS-XX, continuing to take the lead in the update of the Communications Plan of the PTWS, and advocating for tools for the operational decoding and display of sea level data and other web service tools that organize station metadata according to agreed-on XML schema and provide online status of stations supporting tsunami monitoring. The ITIC Director informed the Group that she had been elected to a 3-year term as a member of the IRIS Global Seismic Network Standing Committee, and indicated that she would represent tsunami interests advocating for improved real-time networks to support the real-time monitoring of seismicity especially in tsunami source regions.

65 She reported to the Group that the ITIC has benefited greatly from co-operations in activities with a number of organizations, noting that the partnerships build greater commitment for sustaining activities for the future through the engagement of a broader and wider audience for support. Towards these ends, she referred to ITIC Staff expertise in tsunami and earthquake disaster management as these aspects are critical for enabling an end-to-end tsunami response and sustained preparedness. She indicated that she would report on the ITSU Training Programme under Agenda Item 6.1, on ITIC cooperation with the IUGG Tsunami Commission under Agenda Item 9.1, the WDC-SEG – Tsunamis under Agenda Item 9.2, the SOPAC under Agenda Item 9.3, and ISDR under Agenda Item 9.6.

66 The ITIC Director further reported that in 2006, the ITIC Director will be seconded to the IOC by the USA NOAA to lead the IOC ITIC, and that the ITIC will be formally established as a Programme Office of the IOC through MOU with the USA. These activities are intended to clearly establish the United Nations attributes of the IOC, and thus allow it to receive full contributions to staffing, visiting internships, and other funding resources to build ITIC as the IOC's tsunami information resource and focal point for capacity building in support of tsunami mitigation. At the same time, she emphasized the continued focus of the ITIC directly for assistance to PTWS Member States.

67 She thanked the government of Chile and its SHOA, for continuing to support the ITIC Associate Director position, and for its contributions supporting the printing of tsunami awareness materials that are distributed globally. She emphasized that the ITIC Associate Director support of tsunami mitigation efforts in Spanish-speaking countries has and continues to be especially critical.

68 **The Group expressed its appreciation** to the ITIC for its excellent work during the inter-sessional period.

69 **The Group thanked** the USA for its strong and generous support of the ITIC through staffing, administrative support, and provision of office space.

70 **The Group thanked** Chile for its continued support of the Associate Director for the ITIC, and as its lead for Spanish-speaking Member States.

3.4 PTWC Director's Report

71 The Agenda Item was presented by Dr Charles McCreery, Director, Pacific Tsunami Warning Center (PTWC). The PTWC Director's Report covering activities and changes at the PTWC over the inter-sessional period can be found as Document IOC/PTWS-XXI/9.

72 The PTWC Director informed the Group that between October 2005 and April 2006 PTWC issued 12 Tsunami Information Bulletins in response to large earthquakes in the Pacific and 9 Tsunami Information Bulletins in response to earthquakes in Hawaii. For two of the Pacific events, an Mw=7.1 on 14 November 2005 off the coast of Honshu, Japan, and an Mw=6.8 on 14 March 2005 near Seram, Indonesia, small tsunamis were generated.

73 The Director pointed out that in response to the 26 December,2004 Indian Ocean tsunami tragedy, and a corresponding increased awareness of potential USA vulnerabilities to this hazard, the PTWC staff has been increased from a total of 8 persons in 2004 to 15 persons as of May 2006. The extra staff have facilitated 7x24 operations since 26 April 2006, with one person in the Center and one nearby in a standby status. These additional staff should also facilitate improved services by the Center in all respects.

74 Other improvements have taken, or are taking place, at PTWC in response to the Indian Ocean event. Seismic, hydroacoustic, and infrasound stations of the International Monitoring System of the Comprehensive Test Ban Treaty Organization have been offered to both PTWC and JMA for humanitarian purposes and both PTWC and JMA have begun to receive some of these data. Coastal sea level stations across the Pacific belonging to many countries and organizations are being upgraded by those organizations to better serve the tsunami warning system. The USA is now operating 10 Deep Ocean Assessment and Reporting of Tsunamis (DART) instruments in the Pacific with plans to install a total of 32 in the next two years. Chile is operating one DART with plans for another. In addition, the seismic network operated by PTWC in Hawaii for local tsunami warning purposes is undergoing a major upgrade.

75 **The Group expressed** its appreciation for PTWC's continued provision of timely international tsunami information to the PTWS, and for its commitment to continue to identify and propose new and improved services to its customers.

76 The PTWC Director then proposed some specific format and language changes to PTWC bulletins to make these products more compatible and coordinated with USA National Weather Service products. The proposed changes would eliminate the word "Bulletin" from tsunami products and use the word "Statement" for informational products and "Message" for warning products. The headline line would also be moved more near the top of each product.

77 The proposal generated much discussion and a number of concerns by Member States.

78 As a result, the **Group decided** to form an inter-sessional Task Team to review the proposed changes, consider additional changes, and solicit input from all Member States on the potential impact of proposed changes. The Task Team will comprise the Chairs of PTWS WG5 and IOTWS WG5, plus representatives from all warning centres (JMA, Russian Federation, France, Chile, Australia,

New Zealand, PTWC), plus the PTWS Officers. The task team will report to ICG/PTWS-XXII in 2007. Other ICGs may be asked to participate.

79 Lastly, the Director notified the Group that PTWC will move from its current location in Ewa Beach, Hawaii to a new NOAA Facility being planned for Ford Island in Pearl Harbor, Hawaii. Since the ITIC will also move to the NOAA facility, the move will co-locate the ITIC and PTWC, thus enabling closer cooperation and collaboration. The target date is 2010.

3.5 JMA Director's Report

80 This Agenda Item was presented by Dr Osamu Kamigaichi, Senior Coordinator for International Earthquake and Tsunami Information, Japan Meteorological Agency (JMA). The JMA Director's Report, summarizing the substantial progress during the inter-sessional period and providing information on the future improvements in tsunami warning services of the JMA, is provided in Document IOC/PTWC-XXI/12. He reported that Member States were officially informed through IOC Circular Letter 2187.

81 He informed the Group of the increase in the JMA permanent tsunami staffing starting in 2006 in response to the 2004 Sumatra tsunami. He reported the official inauguration of the Northwest Pacific Tsunami Advisory Center as of 1 February 2006 after about 1 year as a developing Centre, and the start of interim tsunami advisory services for the South China Sea Region as of 1 April 2006. A feature of these advisory is the inclusion of quantitative tsunami wave forecasts derived from pre-calculated databases. The JMA also continues to provide interim Tsunami Watch Information for the Indian Ocean.

82 Dr Kamigaichi provided a summary on the use of the Comprehensive Test Ban Treaty Organization's International Monitoring System (IMS) stations for improving earthquake source characterization (Agenda Item 3.9). JMA tests show that use of these stations, which are closer and of high-quality, would allow the determination of depth and issuance of more accurate tsunami warnings earlier. He reiterated to the Group the need for continued technical tests using the IMS data streams, especially with regards to a station's data quality, and data collection and transmission latency or delay and stability.

83 He informed the Group on the progress of the JMA to improve its national tsunami warning service through the incorporation of CMT solutions and use of its earthquake early earning technique developed to determine an earthquake's hypocentre and magnitude within seconds, with the goal of providing a tsunami warning within two minutes.

84 He informed the Group that JMA will soon transmit to PTWC sea level data measured by pressure sensors installed on two ocean-bottom cable systems located in the Tokai area and off Boso Peninsula, and off Minami-Torishima Island.

85 **The Group thanked** the government of Japan and its JMA for its initiative to start a sub-regional warning service for the Northwest Pacific and for extending the service to the South China Sea on an interim basis.

86 **The Group further welcomed** the initiative of the JMA to conduct tests on the use of the IMS network for improving the monitoring and characterizing of earthquakes in the Pacific and Indian Oceans.

3.6 IOC Tsunami Coordination Unit

87 This Agenda item was presented by Masahiro Yamamoto, Senior Tsunami Advisor of the IOC Tsunami Coordination Unit headquartered in Paris, France.

88 The IOC in Paris created the new tsunami unit in October 2005. There are now three offices; Perth, Paris and Hawaii. The IOC Regional Office in Perth hosts the ICG/IOTWS Secretariat funded by the Australian government and currently staffed by Jane Cuneen. She will be joined by the Head of IOTWS Secretariat in a few months and possibly a secondment from an Indian Ocean country. The office in Paris has five professionals, including Ulrich Wolf, Masahiro Yamamoto, and Bernardo Aliaga. The Head of the Tsunami Unit, a position funded by Norway, will commence duties shortly.

89 The ICG/PTWS Secretariat is hosted by the ITIC office in Hawaii, and is supported by the USA NOAA NWS and Chile SHOA. The ITIC Hawaii office is staffed by five including Dr Laura Kong (Director, to be seconded to IOC) and Brian Yanagi.

90 The Chair thanked the Senior Tsunami Advisor for his report. He recalled the Group's request from PTWS-XX to the IOC Executive Secretary for clarification of the responsibilities of the Tsunami Unit in relation to the PTWS Secretariat and those of other newly established ICGs, and expressed hope that he would receive this information in the near future.

3.7 Recruitment of New Members to the PTWS

91 This Agenda item was introduced by the ITIC Director as the PTWS Technical Secretary. The Director provided an overview of the PTWS Member States, and encouraged observer countries that were not yet members to join. She stated that requests for membership and designation of an IOC Action Address and PTWS Tsunami National Contact should be received from a high level official of the country, but reiterated that there was no membership cost to join either the IOC or the PTWS.

92 The Director informed the Group that the Government of Papua New Guinea became a member of the IOC in April. She looked forward to receiving their request to become a member of the PTWS in the near future.

93 The Director reported that inquiries have been received from Brunei, Cambodia, Kiribati, Niue, Panama, Tokelau, Solomon Islands, and Vanuatu.

94 She noted that a number of island nations in the North Pacific have meteorological services supported by the USA which is an active member of the PTWS, but nonetheless encouraged these countries to become members of the PTWS in order to benefit from the wealth of expertise of the ICG/PTWS, as well as its free products and services. She thanked Australia for organizing a Pacific Island Country Tsunami Workshop prior to the ICG/PTWS in order to increase tsunami awareness in the region.

95 Australia reported that it has approached the twelve Pacific Island countries that are currently not members of the IOC and/or PTWS to encourage them to join. As a result several Pacific Island countries have indicated their intention to join. Australia will continue to actively encourage all PICs to participate in the PTWS.

96 **The Group urged** all Pacific countries to join the ICG/PTWS as soon as possible so as to take advantage of the broad and deep experience and expertise of the ICG/PTWS, its warning centres, and the ITIC in building preparedness against tsunamis.

3.8 "Exercise Pacific Wave '06" Task Team Report

97 This Agenda item was presented by Mr. Mark Sullivan, Emergency Management Australia, as the Task Team Chair

98 At ICG/ITSU-XX in Viña del Mar, Chile in October 2005, Member States noted that a Pacific Ocean-Wide Tsunami exercise had never taken place, and agreed that an exercise of the Pacific Tsunami Warning and Mitigation System (PTWS) should be conducted in 2006 to evaluate the

current level of capability, to identify the current level of readiness of the PTWS, and, more importantly, to identify gaps so as to improve services.

99 Exercise Pacific Wave 06 (EPW06) will enact two tsunami scenarios to carry out the exercise on 16-17 May 2006. Pacific countries can participate in one recommended scenario from 1) an earthquake originating in Chile, or 2) an earthquake originating north of the Philippines. This will permit countries to participate during reasonable work hours across the 13 time zones of the Pacific and South China Sea. To further assist in this regard the exercise will run in compressed time (4:1). Custom Tsunami Travel Time maps will be prepared for the accelerated tsunami speeds. The exercise is a functional style that aims to involve communication and decision making at the Government levels without disrupting or alarming the general public. Individual countries have the option to extend the Exercise down to the level of actually warning the public.

100 The purpose of the EPW06 is to evaluate the ability of Pacific countries to respond to an ocean-wide tsunami. There are six primary objectives for the exercise, which focuses on validating communication and decision-making processes. The six objectives include 1) validate the Tsunami Warning Centres' dissemination process of issuing Tsunami Watch and Warning Bulletins to Pacific Basin countries; 2) validate the process for countries to receive and confirm Tsunami Bulletins; 3) validate dissemination of the warning message to relevant agencies within a country, provinces and local jurisdictions; 4) validate the organizational decision making process about public warnings and evacuations; 5) identify the modes that would be employed to notify and instruct the public; and 6) assess the elapsed time until the public would be notified and instructed.

101 The Exercise Pacific Wave Manual (IOC Document IOC/PTWS-XXI/14) has been prepared to facilitate participation in the exercise. This is available at http://ioc3.unesco.org/ptws/21/exercise_pacific_wave_06.htm

102 The exercise will operate by way of bulletins issued by PTWC, with corresponding bulletins being issued by WC/ATWC (first scenario) and NWPTAC (second scenario). To avoid any possible misinterpretation, bulletins issued by the warning centres will be in 'Dummy' exercise message format that will refer participants to a specific scenario bulletin number in the exercise manual. Participants in EPW06 can refer to the manual to view what actual bulletins for the scenario would look like and to simulate responding accordingly.

103 UNESCO will issue an international Media Advisory about one week before the exercise with more details on EPW06, after the initial media release in late April. ICG/PTWS Member States are encouraged to issue their own exercise press releases to their respective country's media in conjunction with UNESCO releases so that adequate alert is provided to their country's population and to give the local media time to conduct interviews and documentaries. The UNESCO media releases will be posted on the PTWS web site.

104 All participating countries will be asked to provide brief feedback on the exercise to be submitted within three weeks of the exercise. This feedback will greatly assist in the evaluation of Exercise Pacific Wave 06 and assist in the development of subsequent exercises.

105 In addition, a formal evaluation will be conducted to validate strengths and identify improvement opportunities for the participating organisations. The evaluation will focus on the adequacy of plans, policies, procedures, assessment capabilities, communication, resources and inter-agency/inter-jurisdictional relationships that support effective tsunami warning and decision-making at all levels of government. All participant countries are requested to complete the official Exercise Evaluation Forms and return forms back to the Exercise Task Team within 4 weeks after the EPW06. A Final Report will be prepared and available for presentation at the IOC Assembly in 2007.

106 **The Group expressed** its appreciation to the Task Team for its work during the inter-sessional period and to the PTWC, JMA, and WC/ATWC for providing the scenarios and exercise

messages, and **encouraged** all countries to participate to EPW06 in order to test their level of readiness and preparedness for tsunami emergencies.

107 **The Group agreed** to hold the exercise on 16-17 May 2006. The Group **further agreed** to add a question on the post-event feedback form asking countries if they feel it would be worthwhile to conduct the exercise annually.

108 **The Group looked forward** to receiving the Preliminary Report in June 2006, and the Final Report in June 2007.

109 **The Group decided** to assess new scenarios for future exercises and asked the PTWS Officers to consider this topic at the next Officers Meeting that will prepare for PTWS-XXII.

3.9 Tonga Earthquake and Tsunami, 3 May 2006

110 At the start of Day 2 (4 May 2006) of ICG/PTWS-XXI, the Director of PTWC provided a short overview of the M7.8 earthquake that occurred earlier in the day near Tonga. He reported that in addition to consultations with his PTWC Staff, the ITIC Director, Director CPPT French Polynesia, and ITSU Past-Chair were involved in the response. The ITIC Director reported to the Group that two summary documents were posted to the PTWS Web Site http://ioc3.unesco.org/ptws/21/PTWS-XXI_working_documents.htm as IOC Document IOC/PTWS-XXI/15) to provide an overview of the earthquake and tsunami.

111 The PTWC issued three messages (#1 15 min, # 2 64 min, and #3 129 min after the earthquake) in accordance with their standard operating procedures. The initial magnitude was 8.1, and this was changed to 7.8 in the second bulletin. Waves were reported to be small (about 1 ft a Pago Pago, American Samoa).

112 The PTWC Director asked for information from Member States as to their response to the event. The Delegate from Australia reported that its system had been activated, and that the Australian Tsunami Alert System (ATAS) system was engaged. The Delegate from New Zealand reported that the PTWC Bulletins were received. However, he reported that the Public Media handling did not go well, noting that as the media are getting PTWC tsunami bulletins simultaneously, the media has apparently misinterpreted the bulletin to mean that a warning had been issued for New Zealand that required an evacuation. He noted that media also expected immediate assessments and actions, whereas evaluations and decisions were still being made by New Zealand Civil Defense and Emergency Management.

113 **The Group thanked** the PTWC Director for providing a short summary on the event that occurred earlier in the morning. **The Group noted** the good value of capturing lessons learned on an ongoing basis in order to drive the direction in which services should be improved, and **encouraged** Member States to undertake such analyses for large events.

114 **The Group expressed** strong concern that media could misinterpret messages that were intended for national authorities trained to understand and interpret the international tsunami bulletins. **The Group encouraged** warning centres to keep media informed and to consider adding wording to Bulletins that media should speak to Local Emergency Management authorities after a possible tsunamigenic event in order to obtain official information on public safety advisories.

115 **The Group noted** that the downgrading of earthquake magnitudes which changed the status of Bulletins can cause confusion, and **requested** that the Task Team on Messages formed during PTWS-XXI take this intervention and other Member State concerns received from this Session into consideration in making recommendations on changes to the PTWS messages.

3.10 Seismological Observations and other related matters

3.10.1 Report of Inter-sessional Meeting of ICG/PTWS Working Group 1 on Seismic Measurements, Data Collection and Exchange

116 The Working Group (WG) 1 met under the chairmanship of Dr Stuart Weinstein (USA) for two meetings during the inter-sessional period, on 15-16 March 2006 in Honolulu, Hawaii, USA, and on 2 May 2006 in Melbourne, Australia. WG1 reviewed and agreed to continue its Terms of Reference and formulated recommendations concerning measurement of seismic parameters, seismic data collection and exchange for ICG/PTWS XXI. The Reports of the Working Group meeting are provided in Annex VIII.

117 The Working Group noted as important the following discussion topics as motivations. These include the importance of:

- Ensuring that the warning centres are using the most prudent seismological analysis consistent with their operational mission and to facilitate exchange of ideas amongst the warning centres.
- Ensuring that nations in the Pacific Basin with an elevated local tsunami hazard are made aware and provided with recommendations on how to address their threat, recognizing that the PTWC or regional warning centres will not be able to adequately warn for a local tsunami threat in their local areas.
- Recognizing the key role played by data providers for their provision of the volume of high quality broadband seismic data critical to warning centre operations, and ensuring that these data providers will have continued support to maintain and expand their existing networks. Further, recognizing for the tsunami warning system the need to actively encourage research of other technologies and methods, and their integration into the PTWS operations.

118 The 20 recommendations made at the WG1 inter-sessional meeting in Honolulu (15-16 March 2006) fell into five categories. The suggestions and additional recommendations made in Melbourne also fell into these same five categories resulting in a total of 26 recommendations. The full recommendations are found in the Working Group 1 Summary Report (Annex VIII). These categories are:

- Infrastructure of Seismic Networks/Data Access
- Filling in the Gaps of the PTWS (in terms of both instrumentation and coverage)
- New technologies for Tsunami Warning
- Sharing Operational Techniques and Procedures
- Other Recommendations

119 The Working Group acknowledged the need to take an accounting of existing tsunami warning seismic networks in order to arrive at more informed decisions as to how to use and leverage existing assets, and where or what additional assets may be needed to improve the level of services. The Group highlighted as an example the progress of Nicaragua in developing its national tsunami warning system, and El Salvador in implementing a new warning system.

120 Recommendations covering the infrastructure of seismic networks and data access included recognition of the important value of the Global Seismic Network (GSN), as well as the international and Member State organizations toward this Network, but noted that the function of these organizations is primarily for earthquake monitoring and research, and not tsunami warning. The WG strongly stated that it is essential that the GSN and other contributing networks be sustained at high levels of operational reliability for tsunami warning. The WG stated that open and unrestricted access to real-time data, both seismic and sea level, are essential for both research and operations. The Group recognized the CTBTO and the high value of the IMS network, and recommended that this

data flow be continued, as the CTBTO shares its Global Communications Infrastructure (GCI) with the GSN, and this telemetry is vital for tsunami warning systems.

121 The WG recognized the worldwide coverage and open data availability of stations of the International Federation of Digital Seismograph Networks (FDSN), and *recommended* that global, regional, and local Tsunami Warning Systems work with FDSN and its member networks to incorporate real-time data from available FDSN stations.

122 With regard to PTWS Core Network, the WG recognized and *recommended* that the GSN constitute the basis for the Pacific Core Network, encouraged the designation of additional real-time FDSN stations in the Core Network, and agreed that additional stations to densify the network, such as in the Southwest Pacific, South China Sea, and seaward of major seismogenic zones, will be very valuable.

123 The WG agreed that for real-time tsunami monitoring, waveform completeness and timeliness of receipt were the most important performance metrics. Complete data must have little or no gaps. Latency should be as small as reasonable. The WG *recommended* definitions of Completeness and Latency to facilitate the discussion of seismic transmission standards. It was recognized that Latency is comprised of several components; data record size (buffer), telemetry (including internet) latency, data reformatting and server latency. The WG *recommended* that transmission latency should be defined as the difference between current time and the time of the last datum received in the most recent packet, emphasizing the vertical 20sps channel. Networks should note the respective data record size for channels. Measures of latency should include median statistics to avoid effects of large outliers. Data servers should measure and note server latency due to data reformatting or internal buffers. The amount of tolerable latency depends on need. It is *recommended* that for teleseismic processing, buffer latency of 20 seconds is desirable and a buffer latency of a second is desirable for local seismic processing.

124 In the area of filling in the gaps of the PTWS seismic network, in terms of both instrumentation and coverage, the WG recognized the limitations of the PTWC to provide local tsunami warnings (outside of Hawaii), and *recommended* each Member State to consider national or coordinated sub-regional tsunami warning centres to address local tsunami hazards. The WG encouraged Member States with local capabilities to share their know-how and experience. It *recommended* that guidance on the establishment of local warning capabilities be addressed by the Working Group on the Medium-Term Strategy for the Pacific Tsunami Warning and Mitigation System.

125 Examples of regions which have significant threat from locally-generated tsunamis, but which are not served by the PTWC international messages are the Southwest Pacific and Central America Pacific Coast. The WG reaffirmed the Action Plan developed by eight SOPAC Member States during the South Pacific Tsunami Awareness Workshop in July 2004. The WG *encouraged* the Working Group for the Central America – Pacific Coast Tsunami Warning System to actively continue its activities to enable the timely dissemination of local warnings to coastal populations.

126 In the area of new technologies for Tsunami Warning, the WG recognized GPS to be a promising technology for quickly measuring displacements resulting from earthquakes in real-time. Such technology is potentially very useful to address the local tsunami warning problem and great global earthquakes. The WG *recommended* that further research was needed to evaluate the use of GPS for tsunami warning methodologies.

127 The WG noted with concern that STS-1 sensors are no longer being manufactured, and that no adequate replacement is in sight, and stated that it is necessary for the continued integrity of the tsunami warning system that a successor be developed as soon as possible.

128 With regard to filling in the gaps in the seismic network, the WG recognized that all seismic coverage is from land-based seismic stations, and that almost no coverage is available seaward from the major seismogenic zones around the Pacific. The WG noted this as a fundamental gap in the PTWS' ability and speed to characterize the earthquake source in near real-time, and *recommended* network enhancement with seafloor seismic and acoustic sensors. It noted that operational tsunami warning should take advantage of new cabled geo-ocean observing systems going in around the world and consider ways in which to deploy deep-ocean broadband seismometers able to transmit their data in real-time either continuously or upon trigger, and *recommended* that the IOC facilitate communication between the warning centres and the groups deploying these deep sea observing systems.

129 The WG noted the need to explore the use of strong motion sensor arrays to rapidly determine the size and nature of the rupture of large earthquakes, and encouraged modeling to be conducted to establish criteria for assessing the appropriate thresholds for ground accelerations recorded by these arrays at which the genesis of a destructive tsunami is likely. The use of broadband sensor arrays to determine earthquake rupture characteristics was also recognized to be of high relevance.

130 In the area of sharing operational techniques and procedures**, t**he WG *highly recommended* that regular scientific symposia be convened to focus on improving tsunami warning systems and their operational procedures. The WG noted that the IUGG Tsunami Commission has convened such meetings on tsunami research, but not on operational systems, and further noted the need and high value for such symposia on real-time seismology. Research plays a fundamental role in developing better ways of characterizing earthquakes and their potential for tsunamigenesis, and it is critical that this research be developed into operational tools.

131 The WG *encouraged* existing TWCs to make their operational software available to developing TWCs. TWCs should move towards more modular, portable, open-source, platform-independent software to help facilitate this type of exchange, and to help fast-track the start of national tsunami warning centres. The WG commended the PTWC for beginning this process with some of its operational software.

132 The WG completed its work by recognizing that additional threats from tsunamis are generated by landslides, volcanic explosions, and meteorite impacts, but acknowledging that current tsunami warning systems cannot adequately warn for these events. The WG *recommended* that further evaluation of these threats is merited.

133 In regards to global synergies for monitoring and evaluation to support tsunami warnings, the WG identified the strong need for synergy between other ICG Seismic Working Groups in the Indian Ocean, Caribbean and Adjacent Regions, and the North-eastern Atlantic, Mediterranean, and Connected Seas, and called for the IOC to take a leadership role in integrating and coordinating common activities.

134 **The Group thanked** the Working Group 1 Chair for his excellent and comprehensive report, and for their thorough evaluations of the current status of networks and seismic evaluations supporting tsunami warning. **The Group accepted** the Summary Report of Working Group 1 and the recommendations therein.

3.10.2 Global Seismographic Network

135 The Agenda Item was presented by the Director of PTWC, on behalf of the Programme Manager Dr Rhett Butler of the IRIS Global Seismographic Network (GSN)

136 The GSN is a multi-use, inter-agency international facility used primarily for research but also used to evaluate earthquakes for tsunamigenic potential, nuclear monitoring and earthquake hazards. There are 138 global stations and arrays, with 59 nations involved. Local hosts are fundamental to

success of the system. It has taken 20 years to put the array together, and a $100M facility was built over 20 years. The telemetry links, including the national weather service, are contributed to by many international organisations. The installations are solid and designed for the long-term. Many existing sites will shortly be getting telemetry upgrades, and will be freely available.

137 Performance goals include free and open access to data over internet. Data are available in real-time without any delay or restrictions. The aim is to have a complete and continuous archive with good quality control and a high data return. The data is communicated in real-time either over satellite links or over the internet. This makes it most useful to PTWC.

138 For the most part, seismic stations able to quickly record an earthquake near major subduction zones are located on land on only one side of the subduction zone. There is a need to locate stations on the other side of subduction zones (in the ocean), as part of every tsunami monitoring system. This gap leads to an incomplete characterisation of the earthquake source.

3.10.3 Tsunami Observations on Seismic Stations

139 Dr Dominique Reymond, Director of Centre Polynésien de Prévention des Tsunamis (Tahiti, French Polynesia) presented the results of a preliminary study concerning the observation of tsunami on seismic stations. Some clear observations of tsunami recorded by seismic instrumentation have been made, not only for the huge 2004 Sumatra event, but also for a moderate tsunami, such as from the Peru 23 June 2001 earthquake that generated a 15-cm tsunami in Papeete Harbor. The observation of tsunamis using broad-band seismometers (period greater than 200s such as LPH-12A and STS1) are viewable on the horizontal component, but with very small amplitudes and involving a complex transfer function to convert tsunami pressure on the coast to seismic waves. Recovery of the true tsunami amplitudes is planned in future studies.

140 The advantages of this method are the following: 1) real-time reception and processing of data at facilities recovering seismic data (IRIS, LISS, etc.); 2) extension of the sea level monitoring network through the use of broad-band seismic networks (with stations close to the sea); and 3) use seismic stations as a backup when sea level stations fail or record out of range due to large tsunamis. Advantages of using seismometers include the recording of time series that are not affect by bay resonance and also the much higher sampling frequency that would then allow for high frequency studies of tsunami to be carried out.

141 **The Group recognized** the potential importance of these tools for improving tsunami warnings, and **requested** France to provide a technical information document to the next ICG Session.

3.11 Sea Level Observations and other related matters

3.11.1 Report of Inter-sessional Meeting of ICG/PTWS Working Group 2 on Sea Level Measurements, Data Collection and Exchange

142 Working Group (WG) 2 met under the chairmanship of Rick Bailey (Australia) from 1-2 May 2006 in Melbourne, Australia. WG2 reviewed and revised its Terms of Reference and formulated actions and recommendations on sea level measurement, data collection and exchange for ICG/PTWS XXI. The Report of the Working Group meeting is provided in Annex VIII.

143 The Revised Terms of Reference for Working Group 2 are as follows:

- Review and report on existing arrangements with regard to sea level data collection and exchange

- Ongoing review and monitoring of status of Pacific Ocean sea level networks related to tsunami observation.
- Coordinate plans for sea level observing sensitivity tests to understand the optimal, effective PTWS sea-level network and associated technologies.
- Liaise with other sea level measurement, data collection and exchange working groups from other ocean basins, as well as other working groups within ICG/PTWS to coordinate and ensure efficient and effective sea level observations for tsunami warning.
- Liaise with WMO, JCOMM and relevant Expert Teams, such as the WMO Commission on Basic Systems (CBS) and the JCOMM Global Sea Level Observing System Group of Experts (GLOSS GE), to develop a more effective data representation and code form for the exchange of sea-level data (standards, metadata requirements)
- Review and report on various means of transmitting sea-level data to warning centres and to conduct test of latency (timeliness) of GTS transmissions.

144 The WG recommended that the ICG/PTWS WG2 continue during inter-sessional period and meet prior to ICG/PTWS-XXII to ensure coordination and ongoing focus on Pacific Ocean issues by members in the region.

145 The Working Group made Recommendations and identified Actions on sea level data requirements for tsunami monitoring and warning, sea level network design principles, sea level measurement technology, and intra- and inter-ocean basin coordination. WG 2 will report to PTWS-XXII on the status of its identified Actions.

146 On the topic of Sea Level Data Requirements for Tsunami Monitoring and Warning, WG 2 reported as:

Priorities:

Priority 1:

- Operational Tsunami Detection & Warning
- Verification, including “all clear”

Priority 2:

- Modelling & Forecasting
- Warning
- Hazard & vulnerability assessment
- Historical data and metadata

Recommendation:

- To include feedback from post event analyses into the ongoing review of PTWS network design.

Actions:

- PTWS WG 2 and the IOTWS WG 2 to coordinate development of network design principles by ICG/IOTWS-III in Bali in July 2006 (Chair, Australia).
- PTWS WG 2 to seek further input from modelling working groups on data requirements for warning and forecasting.

147 On the topic of Sea Level Network Design Principles, WG 2 reported as

Recommendations:

- Wherever possible and in the interim, sea level stations should conform to GLOSS climate-related standards. WG 2 noted that since requirements for tsunami detection are less stringent, sea level stations could be installed at less cost where critically needed for tsunami warning guidance

- Wherever possible, installation should be of multi-purpose observing sites to facilitate the long-term sustainability of the observing network

Action:

- For GLOSS / UHSLC to advise by ICG/IOTWS-III in Bali July 2006, on the cost of installing a typical sea level gauge, both for a new multi-purpose GLOSS standard installation for monitoring sea level for climate change detection and tsunami detection, and the cost for only upgrading a GLOSS station to meet tsunami warning requirements.

148 On the topic of Sea Level Measurement Technology, the WG 2 reported as:

Action:

- The need to coordinate and communicate outcomes from evaluations of existing and new technologies (e.g. radar).

149 On the topic of Intra- and Inter-Ocean Basin Coordination, WG 2 reported as:

Recommendations:

- That the ICG/PTWS WG Chairmen participate on Medium Term Strategy WG to ensure coordination on status and developments in respective areas;
- That the CREX format for the transmission of sea level data over the WMO GTS be adopted by the PTWS, and be considered for adoption globally by the ICGs;
- That the International Tsunameter Partnership concepts and Terms of Reference be endorsed so as to ensure the interoperability of deep-ocean measurements and coordination of deployment opportunities;
- That the Chairman of ICG/IOTWS WG 2 be a member of ICG/PTWS WG 2 in order to help coordinate between basins and identify joint issues of concern;
- That the respective ICG/PTWS and IOTWS WG2 chairs, or their representatives, participate in GLOSS meetings to facilitate coordination of requirements.

Actions:

- To develop template by end of May 2006 for Pacific Ocean nations to provide status information and national plans for deployments by end of July 2006 to facilitate status monitoring, maintenance and development of sea level network programs. WG 2 identified Dr. Jane Warne (Australia) and National Representatives for this Action;
- That a Joint ICG/IOTWS WG2 and ICG/PTWS WG2 Sub-WG to review tables and metadata;
- That coordination includes the ITIC with view to ongoing maintenance and access to database.

150 **The Group thanked** the Working Group 2 Chair for his report. **The Group accepted** the Summary Report of Working Group 2 and the recommendations and actions therein.

3.11.2 GLOSS Report

151 This Agenda item was introduced by Mr. Bernard Kilonsky of the University of Hawaii Sea Level Center, on behalf of the Chair of the GLOSS Group of Experts.

152 He informed the Group that GLOSS offers in-situ sea level gauges, as well as assists the ICGs to set data standards, offers training courses, provides technical visits technical manuals and training material, and holds workshops on special issues.

153 He emphasized the high value of using sea level stations for multiple purposes since it maximizes the likelihood of maintenance and the continuous operation of the sea-level measurement network. The sea-level data acquired through these sites are thus much more sustainable since they are used in climate, oceanographic and coastal sea level research, and other purposes. The station specifications are designed for long-term sea level monitoring and configured for basin-wide, sub-regional and national tsunami monitoring systems. The stations should report in such a way as to provide timely and useful sea level data to operational tsunami warning centres such as PTWC and JMA. He informed the Group that in addition to PTWC and JMA, the sea level data messages are also available for immediate re-transmission using WMO's GTS facilities to national meteorological centres serving as Tsunami Warning Focal Points, and thus can help national tsunami warning centres confirm the existence of a major tsunami or to cancel a tsunami watch or warning.

3.11.3 DART SEA LEVEL NETWORK REPORT

154 The Delegate from the USA indicated that the pertinent information was covered in other presentations, including the USA National Report (Document IOC/PTWS-XXI/7.17) and the inter-sessional report of Working Group 2 (Annex VIII).

3.11.4 XML SEA LEVEL STATION REPORT

155 This Agenda item was presented by the ITIC Director. She referred to Documents IOC/PTWS-XXI/16 for details on the web service tool, and to the reports of IOC/INF-1226 and 1227 which summarized meetings for the real-time transmission, decoding, and displaying of the sea level data to support tsunami warning operations.

156 The Director reported that the XML Sea Level Station Project, funded by 2005 USA NOAA PRIDE money involving the ITIC, Pacific Disaster Center of the East-West Center, the PTWC, and the NOAA NOS Pacific Services Center, focused on the feasibility of using a XML schema design for global water level station metadata in support of Tsunami Warning Monitoring Operations. A prototype was shared with attendees at the *Meeting on the Development of an ODINAFRICA Sea Level Data Facility* at the Intergovernmental Oceanographic Commission (IOC) Project Office for International Oceanographic Data and Information Exchange (IODE), Ostend, Belgium, 29-30 March 2006 (IOC/INF-1227).

157 The team discussed the dual objectives of the project, namely, 1) exposing the tide gauge station metadata using XML, and, 2) harvesting this data using a web service. While generally agreeing on XML as backend integration technology, the team decided to focus pilot activities for developing, and *equally* emphasizing, clients for the services built on this schema. A concept paper was jointly authored at the IODE to express this collective team vision, from both the "data providers" as well as "service host" perspective. As stated in the concept paper, the objective of the proposed demonstration project is to develop a distributed metadata system describing sea level stations—starting with pilot activities in a regional framework, and focusing on tsunami detection and warning systems being developed by the IOC and partners.

158 Later, at the ODINAFRICA meeting 24-28 April 2006, the proposed pilot project was approved (as described by the IODE concept paper) with a specific interest in developing *TideTool* developed by Dr Stuart Weinstein of the PTWC as the initial consumer of the sea level station metadata. The metadata would be exposed using the agreed-on XML schema, thus eliminating the need to maintain the hard-coded elements of *TideTool* code dedicated to parsing various station metadata (IOC/INF-1226). *TideTool*, based on the PTWC operational *Watertool* software, is a operational tool which utilizes transmissions from the WMO GTS for continuous logging, decoding, and displaying of all incoming sea level data streams. *TideTool* has been deployed operationally in Indonesia, Malaysia, Singapore, Maldives, India, and New Zealand; further inquiries have come from Sri Lanka, Oman, and the Seychelles.

159 A *TideTool* demonstration visualization has been developed that is currently accessible through the internet in a non-operational mode for Indian Ocean stations. The continuously updated non-interactive display provides a quick overview of the status of all stations received in near real-time by the PTWC. The web site is http://iodeweb2.vliz.be/tsunami. Dr Kong reported that in the next months, the prototype will be further developed and additional features added to build a useful operational tool with direct application to use by the ODINAFRICA Sea Level Facility. In parallel and complementary to this, the NOAA PRIDE 2006 project plans to implement a Wave and Water Level (WWL) Web Service supporting tide station system databases, dissemination of message products, and related tide data products developed by the PTWC.

160 **The Group recognized** the potential importance of these tools for providing accessible information on the status of sea level networks used for tsunami warnings, and **requested** the Project to provide a technical information document to the next ICG Session.

3.12 Tsunami Hazard Identification and Risk Assessment and other Related Matters

3.12.1 Report of Inter-sessional Meeting of ICG/PTWS Working Group 3 on Sea Level Measurements, Data Collection and Exchange

161 Working Group (WG) 3 met under the chairmanship of Dr François Schindele (France) on 2 May 2006 in Melbourne, Australia. WG 3 reviewed its Terms of Reference and formulated actions and recommendations on tsunami hazard identification for ICG/PTWS-XXI. The Report of the Working Group meeting is provided in Annex VIII.

162 WG 3 made the following Recommendations to ICG/PTWS-XXI:

- Inter-sessional Working Group Three on Tsunami Hazard should continue through at least the next inter-sessional period. Greater participation from Member States is needed.
-
- Member States will provide information to ITIC on the Tsunami Modeling software used in their country, the related documentation, manuals and references. ITIC will collect this information and provide to IUGG/Tsunami Commission for review.
-
- Member States will provide completed questionnaires on credible seismic scenario(s) (ITIC will transfer questionnaire provided by Chair WG3).
-
- Member States are requested to provide information on their Tsunami Hazard and Risk activities in their National Reports.

163 **The Group thanked** the Working Group 3 Chair for his report. **The Group accepted** the Summary Report of Working Group 3 and the recommendations therein.

3.12.2 Integrated Tsunami Database Project (ITDB) Report

164 The ITIC Director introduced this Agenda item, and informed the Group that a detailed Report is provided in Annex IX (Document IOC/PTWX-XXI/16).

165 She recalled that there are currently two global historical tsunami databases that are maintained separately by WDC/NOAA (Boulder) and the NTL/ICMMG (Novosibirsk). At ICG/PTWS-XX, the Group reiterated its request for merging the two databases into a single one for wide distribution. Upon discussion of the parties, a new plan for merging these databases, it was decided that the databases would continue to be maintained independently, but efforts would be focused on bringing the two databases into agreement by beginning with verification of the most

deadly tsunami events. A deadly tsunami event was defined as causing > 5 deaths or a maximum runup of > 5 meters. A decision was also made that the source event data verification would include information on the date, time, location, and magnitude of the earthquake, and if applicable, maximum event runup, and effects. The effects include the total number of fatalities, injuries, houses destroyed, and damage. If the information is available, the effects as a result of the source event and the tsunami would be listed separately in the databases. Verification of all of the data describing the run-ups associated with these events would not be done until the descriptions of the most deadly events matched in the two databases.

166 The ITIC Director then yielded the floor to the Delegate from the USA for his summary of the activities of the WDC/SEG-Tsunamis and the NOAA National Geophysical Data Center.

167 He reported that WDC/NOAA prepared a list of "significant" tsunami events based on the data in both databases and provided the list to NTL/ICMMG. The initial list contained 281 tsunami events. The list now contains 270 significant tsunami events. The WDC/NOAA historical tsunami database currently contains 1,488 valid events (not erroneous or meteorologically caused) and 7,838 runup observations (not doubtful). The distribution of causes for these events is 86% earthquakes, 5% colcanoes, 3% Landslides, 5% combination, and less than 1% unknown. WDC/NOAA has now verified 50% of the most deadly tsunami events. These data are available on the WDC/NOAA website via forms-based interfaces and interactive maps.

168 WDC/NOAA's quality control efforts have been focused in two areas. As part of a U.S. tsunami hazard assessment project, WDC/NOAA first focused on events that caused fatalities in the United States, territories, and commonwealths. Secondly, in 2005, ITIC and WDC/NOAA obtained a license to provide the Tsunami Travel Time (TTT) software, developed by Dr Paul Wessel (University of Hawaii) and in use by the Pacific Tsunami Warning Center, as a stand-alone CD-ROM product and as a plug-in to the WDC/NOAA online interactive hazard maps. Tsunami travel-time maps for major teletsunamis in the Atlantic, Indian and Pacific Oceans are available from http://www.ngdc.noaa.gov/seg/hazard/tsu_travel_time.shtml. Each map is linked to search results for the event in the digital historical tsunami database. Data for these source events and the travel times for the associated run-ups were verified. WDC/NOAA used these data for comparison of the observed vs. modeled travel times during the testing phase of the software.

169 He reported that the WDC/NOAA continues to expand its password-protected web-access tools built with the NOAA/WDC Interface Database Tools (IDB). The tsunami, significant earthquake, significant volcanic eruptions, and reference citations are all stored in an Oracle database. Scientists from anywhere in the world can add, update, or delete records in this database.

170 The ITIC Director summarized the Report of the NTL/ICMGG. She reported that in 2006, the main efforts focused on further updating and data verification for 11 of the largest historically known events (so called tele-oceanic tsunamis) responsible for great material damage and most of the fatalities. For these events, the list of observed run-up heights was extended by adding additional data available in recently published catalogs and original publications. In total, these 11 events have 2930 run-up values provided with geographical coordinates of observational sites – it comprises almost 30% of all run-up entries currently available in the database. Special attention was given to collection and verification of the data on spatial distribution of fatalities resulted from these tsunamis. These fatalities were analyzed in terms of their distribution over the tsunami travel time (TTT) intervals. Within the first hour of TTT, 84% of fatalities occur. Another 12% of fatalities happen within the second hour of TTT, and the other 4% occur after that time (greater than 2 hours). She noted that the overwhelming majority of other tsunamis (that is 99.5% of all historical cases and 95% of all damaging events) are the local and regional events whose major damage and all fatalities are limited to the near-source area within 20-40 min of travel time. This is a fundamental fact that should be taken into account in design and implementation of any regional or basin-wide tsunami warning system.

3.12.3 Tsunami Reconnaissance Digital Data Repository

171 The ITIC Director introduced this Agenda item. She provided a summary status of the planned digital repository that is collecting multi-disciplinary, post-tsunami survey data from the Indian Ocean tsunami. The ITIC and WDC/SEG-Tsunamis are providing input to the design on the information portal, which has a goal of being flexible for scientists to upload their data, and simple for users to query the database to extract different types of observations of tsunami impact. She expressed optimism that this may become a prototype for the digital archiving of tsunami data; she emphasized the need for accurate metadata to accompany any submissions. She reported that the site is currently in a pilot test implementation phase with a beta release planned fro August 2006. The Project is a collaborative effort led by Oregon State University scientists and the University of California, San Diego Supercomputer scientists. She referred to PTWS/XXI/19 for further information.

3.13 Resilience Building and Emergency Management and other Related Matters

Report of Inter-sessional Meeting of ICG/PTWS Working Group 4: Resilience Building and Emergency Management

172 Working Group (WG) 4 met under the chairmanship of Fred Stephenson (Canada) on 2 May in Melbourne, Australia. WG4 reviewed its Terms of Reference and formulated discussion points concerning resilience building and emergency management for ICG/PTWS-XXI. The Report of the Working Group meeting is provided in Annex VIII. The meeting was scheduled to integrate into the Pacific Island Countries (PIC) Tsunami Workshop. Due to Workshop commitments the SOPAC representatives were only able to attend the first and last parts of the meeting (presentations and final review/summary).

173 This Working Group received presentations on two examples of best practices. The first presentation, by Dr. Dominique Reymond, CEA/DASE/Laboratoire de Geophysique de Tahiti and Denis Musson, Head of Civil Defense, French Polynesia, discussed recent tsunami exercises in French Polynesia and planned improvements being made to the tsunami warning system as a result of these exercises. A new communication system using Inmarsat-C and a network of sirens on 60 islands is being installed over the next two years. It will be tested on two islands during Exercise Pacific Wave 06.

174 The second presentation was made by Brian Yanagi, International Tsunami Information Centre, on the USA TsunamiReady program. The program is designed to educate local emergency management officials and their constituents and to promote a well-designed tsunami emergency response plan for each community. *TsunamiReady* promotes tsunami hazard preparedness as an active collaboration among governments and local emergency management agencies. This collaboration supports greater and more consistent tsunami awareness and mitigation efforts among communities at risk.

175 The WG noted that PTWS has been in existence for 40 years and in its Master Plan has the stated purpose "to provide or improve all aspects of tsunami mitigation in the Pacific including hazard assessment, warnings, preparedness, and research through a system of international cooperation and coordination of activities." In that context the promotion of best practices in emergency management and resilience building is consistent with both the group's stated purpose and the Hyogo Declaration.

176 The Working Group further noted that traditionally most of the expertise/representation in the PTWS has come from the seismic and sea level communities, but to develop an effective and comprehensive (all-hazards) early warning system there is a need for greater Emergency Manager representation and more interaction with other agencies and groups (e.g. ISDR, WMO). In this context the objectives of WG4 require work in some areas outside the traditional core expertise of the PTWS.

177 WG 1 identified the following as desirable best practice activities:

1. Assessments – The WG noted that some ICG/PTWS members have also completed this questionnaire, but a comprehensive set of assessments (all countries) is required to identify baselines and gaps in capabilities. It requested Member States to complete this questionnaire to support pre-exercise evaluation.

2. Signage – The WG reported that the ICG/PTWS established a working group several years ago to recommend a set of signs for international use, but noted that the approval process has not been satisfactory or conclusive. It recommended that the ICG/PTWS move ahead to promote one or more sign formats to other Tsunami Warning Systems.

3. Educational Materials – The WG welcomed the new *Tsunami Teacher* done by the ITIC, and noted that it will provide more information than ever before and to a broad range of client groups.

4. Information sharing – The WG noted that, in addition to developing and distributing educational material, TWS groups need to also share operational information (e.g. national emergency response manuals and hazard assessments) and link these to all-hazards and capacity building (resilience) efforts.

5. Communication methods – The WG noted that present communication methods do not meet the needs of especially small islands or isolated communities, and that sustainable solutions be identified and recommended. An effective TWS must have communication systems that are reliable, and capable of providing a timely warning to communities.

6. Exercises – The WG emphasized the importance for Member States to complete the post-exercise evaluation forms for *Exercise Pacific Wave 06* in order to help the Group identify and promote best practices.

7. Best Practices – The WG noted that identification and promotion of best practices is not enough; they must be continually improved upon and a process for keeping information up-to-date is needed.

8. High-Level Advocacy – The WG emphasized that advocacy is essential to ensure a sustained commitment to prepare for infrequent, high fatality hazards such as tsunami and earthquakes.

9. Interoperability – The WG noted the PTWS needs to develop a structure for information "inter-operability" – the WG noted that considerable information that is educational and 'non-data' is available, and suggested a global portal as a means for making this information more widely available.

10. Capacity Strengthening within SOPAC Regional Framework endorsed at the 36th Pacific Islands Leaders Forum (Madang, Oct 2005) – The WG emphasized the need to find funding opportunities to support the framework, and the development of Strategic National Action Plans.

178 The Working Group recommended that their work be continued through the up-coming inter-sessional period and that work focus on items (7) and (9) – the identification and maintenance of best practices, and improved information "inter-operability" through a web portal. It proposed that the work should be done by internet (e-mail). The focal points are planned to be Australia (Peter Willett), Canada (Chair – Fred Stephenson), New Zealand (David Coetzee), SOPAC (Attu Kaloumaira), Samoa (Filomena Nelson), and the ITIC (Brian Yanagi).

179 **The Group thanked** the Working Group 4 Chair for his report. **The Group accepted** the Summary Report of Working Group 4 and the identification of best practices for support therein.

3.14 Interoperable TWS and other Related Matters

Report of Inter-sessional Meeting of ICG/PTWS Working Group 5 on Interoperability and regional, sub-regional and national tsunami warning and mitigation systems in the Pacific

180 Working Group Five (WG5) met under the chairmanship of Dr Charles McCreery (USA) on 1 May 2006 in Melbourne, Australia. WG5 reviewed its Terms of Reference and formulated recommendations concerning interoperability issues in the Pacific for ICG/PTWS-XXI. The Report of the Working Group meeting is provided in Annex VIII

181 Comments on this report were also received from observer countries and organizations to the ICG/PTWS-XXI, including several delegates representing the Pacific Island Countries.

Motivation for Interoperability

182 The Working Group noted as important the following key motivations:

- The global tsunami warning system that includes the PTWS is currently operating and will continue to operate with multiple warning centres (TWCs) having adjacent or overlapping areas of responsibility and simultaneous responsibilities for the same events. Information disseminated from multiple centres during events should be coordinated in form and content to avoid confusion or inaction that could in some circumstances result in the unnecessary loss of life.

- Although each TWC may have unique responsibilities and challenges, they also have many similarities. They should work towards a common underlying concept of operations (CONOPS) that will allow them to more efficiently and effectively exchange data, methodologies, technologies, and procedures with each other, as well as with their partners in a multi-hazard framework, and provide backup services for each other, thereby enhancing their reliability and sustainability.

183 A large number of general issues were identified as being related to interoperability. Most were not discussed in much detail nor specific recommendations made. It was agreed, however, to recommend that WG5 continue through the next inter-sessional period and probably through a longer period in order to work further on these issues. A few issues were identified as being of a high priority and sufficiently achievable to be recommended to ICG/PTWS-XXI for consideration as specific action items.

General Issues of Interoperability

184 The WG identified general issues of interoperability that encompassed the need for standardization and consistency in data networks and methods of threat evaluation, alert criteria and decision-making, and message products and dissemination.

185 Under Data and Methods, WG identified the need for:

- Open and free real-time data in common formats with up-to-date metadata
- Specification of requirements for the different warning scenarios in terms of instrument coverage and spacing, sample rates, transmission intervals, frequency response, dynamic range, and other appropriate parameters
- Use of similar data sets, analysis methodologies, and implementations by TWCs
- Validation procedure for critical TWC methodologies, such as numerical forecasting

- Use of open software, programming standards, and platform-independent programming languages to enhance exchange of methodologies

186 Under Alert Criteria and Decision-Making, the WG identified the need for agreement on:

- Standardized levels of tsunami alert, including globally
- Standardized criteria for satisfying each alert level
- Standardized hierarchy of authority of information for different tsunami scenarios
- Need for user-friendly decision-support database of historical data and tsunami model scenarios to aid in pre-event threat awareness, and background information during events

187 Under Messages and Message Dissemination, the WG identified the importance of:

- Standardized content and format of TWC products, and consideration of some multiple-language products
- Standardized and simplified product dissemination methods, with backup strategies

188 The WG also identified the need for the standardization of TWC documentation and portability of tsunami awareness and education materials and training.

Specific Recommendations

189 The WG made nine specific recommendations to the Group:

a. Inter-sessional Working Group Five on Interoperability should continue through at least the next inter-sessional period. Greater participation from Pacific Island Countries is needed.
b. All TWCs should rapidly exchange their earthquake parameters, tsunami observations, and other operational tsunami information. A coordination tool should be developed to enable the (near) real-time internet exchange and display of this information.
c. Practice events such as the Pacific Wave Exercise on 16-17 May 2006, and other more regional or local exercises should continue to be carried out to maintain the level of readiness that will be required during a real event.
d. Areas of responsibility of each TWC should be identified, including the type of coverage provided (local, regional, or teletsunami). Areas in the vicinity of the Pacific without coverage for their threat (e.g., the Banda Sea for local and regional tsunamis) should be identified and existing TWCs should consider providing some type of coverage.
e. Work should continue to improve tsunami preparedness and warning coverage in the SW Pacific, including getting more countries to join the IOC-ICG/PTWS, advising them on setting up their national focal points and national TWCs, and developing an end-to-end tsunami warning capacity.
f. PTWS country assessments that were initiated prior to ICG/ITSU-XX should be completed and evaluated.
g. Regional TWCs should develop Short Message Service (SMS) abbreviated text messages for mobile telephones and SMS dissemination capabilities. Member States should provide SMS contact points.
h. Funding should be provided by the IOC or by Member States for WG5 to meet at least once during the Inter-sessional Period, as well as to facilitate carrying out any WG5 recommendations adopted by ICG/PTWS-XXI.
i. The PTWS Communications Plan should have its procedural information kept up-to-date by PTWC and focal point information kept up-to-date by the IOC (ITIC). The current Plan should be made available by the IOC over the internet and by hardcopy if

requested. Focal point information should be kept secure by password or otherwise for distribution only to ICG/PTWS National Contacts and their designated Tsunami Warning Focal Points.

190 **The Group appreciated** the Working Group's efforts to consider the needs for the PTWS in the context of the requirements for an operational global tsunami warning system. **The Group thanked** the Working Group 5 Chair for his report. **The Group accepted** the Summary Report of Working Group 5 and the recommendations therein.

4. SUB-REGIONAL PACIFIC TSUNAMI WARNING AND MITIGATION SYSTEMS

4.1 Northwest Pacific and South China Sea Regions

191 This Agenda Item was presented by the JMA Senior Coordinator and Delegate from Malaysia.

192 The JMA Senior Coordinator referred to his presentation in Agenda Item 3.5 and the JMA Director's Report. He further commented on the results of the recent Communications Test of the NWPTAC conducted on 23 March 2006 at 0200 UTC, and referred to IOC Document IOC/PTWS-XXI/13 for the results. He urged Member States to continually review and update when necessary their designated Tsunami Warning Focal Points using the TWFP Form in IOC Document IOC/PTWS-XXI/13.

193 The ITIC Director reported that the ITIC, on behalf of the PTWC and JMA, has updated the Communications Plan of the PTWS (IOC/PTWS-XXI/12). Final modifications are now being made and will be available next week on the PTWS web site. She reminded the Group that the version on the web site would be the publicly distributed version without emergency contact information. She indicated that the official complete version with emergency contact information is directly available from the ICG/PTWS Secretariat or ITIC.

194 The Delegate from Malaysia reported on the outcomes of the "International Round-Table Dialogue on Earthquake and Tsunami Risks in Southeast Asia and the South China Sea Region", held 27-28 April 2006 in Kuala Lumpur, Malaysia.

195 The meeting was attended by 80 participants, including representatives from Australia, Bangladesh, Cambodia, China, India, Indonesia, Pakistan, Malaysia, Maldives, Myanmar, Pakistan, Philippines, Singapore, Thailand and Vietnam; tsunami warning centre and disaster preparedness organizations of the Asian Disaster Preparedness Center (ADPC), Japan Meteorological Agency (JMA), University of Hawaii Sea Level Center (UHSLC), and USA Pacific Tsunami Warning Center (PTWC); seismological and tsunami experts from Canada, Northern Ireland, Russian Federation, Turkey, and the USA; the IOC of UNESCO and its Tsunami Unit, the Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System (ICG/PTWS), the Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWS), the GLOSS Group of Experts, the International Tsunami Information Centre, and the private sector.

196 The objectives of the Round-Table were to:

- assess earthquake and tsunami and vulnerability in Southeast Asia and the South China Sea region
- review the level of preparedness and mitigation measures in place and identify gaps/weaknesses
- identify opportunities to strengthen regional and international partnerships, networking and capacity building

197 The discussions shared information on the earthquake and tsunami hazards of Southeast Asia and the South China Sea and the Indian Ocean, noting that for especially the marginal seas of the western Pacific the short tsunami travel times will require dense instrumentation networks and real-time data for effective warning systems against local tsunamis. Also discussed were the implications of the tsunami hazard on coastal communities and the ways in which to mitigate the earthquake and tsunami hazard in order to save lives and reduce property damage. The Round-Table concluded that the risk is high in some areas and that there were varying capacities amongst Southeast Asian countries. The most-affected countries have taken positive steps to mitigate impacts of a tsunami.

198 The Round-Table recognized the IOC leadership as the appropriate entity for the arrangements for operation and establishment of international and regional tsunami warning systems. It appreciated the provision of interim tsunami advisory services for the South China Sea and the development of a communication plan for the South China Sea by JMA under its NWPTAC and by the PTWC. It appreciated the ASEAN Task Force for Tsunami Early Warning for its proactive work to seismic data (July 2005) and sea level data (April 2006) to be shared amongst Member States to enable the earliest of tsunami warnings. It recognized the contributions of the WMO for its provision of the Global Telecommunication System (GTS), and the global Geostationary Meteorology Satellite System, operated by European Space Agency, the Japan Meteorological Agency, and the US National Oceanic and Atmospheric Administration, and the IOC GLOSS, for its provision of sea level stations in support of tsunami warnings.

199 A Joint Statement was endorsed by the Group that included the following Action Plan:

11. Continue the significant progress on assessing earthquake and tsunami and vulnerability in Southeast Asia and the South China Sea region through the support of national and international research initiatives including historical and paleotsunami assessments.
12. Although substantial progress has been made in some countries with regard to tsunami preparedness and mitigation, there are still some gaps and weaknesses, and the countries within the region should continue efforts to address these shortcomings and to raise the general level of preparedness.
13. Build on the regional partnerships that have been developed and strengthen international partnerships through membership and active participation in ICG/PTWS and/or ICG/IOTWS.
14. Ensure long term sustainability by implementing an end-to-end framework in a multi-hazard context.
15. Urge ICG/PTWS to continue to focus on establishing regional TWS capabilities to cover the South China Sea region.
16. Countries in the region to improve sea level coverage in the South China Sea.
17. Promote the free and open exchange of real time seismic and sea level data and information to be used for national tsunami warning and event monitoring.
18. Southeast Asia and the South China Sea region should utilize or build on the PTWS, IOTWS and other existing organizations and institutions in order to achieve durability.
19. Request each country in the region to provide a 7x24 Tsunami Focal Point to the ICG/PTWS Secretariat, ITIC, to receive tsunami warnings issued by the JMA and PTWC.
20. Countries in the Southeast Asia and the South China Sea region should continue to improve their instrumentation and provide the resulting data and information in real time to PTWC and the JMA.
21. Request the ITIC continue to provide advice on the establishment of National Warning Systems, including especially public awareness and education.
22. Request the WMO and its Member National Meteorological Services continue to support the IOC through warning products and data exchange through its Global

Telecommunications System (GTS), and to ensure that the GTS links are adequate for such purposes.

23. Urge capacity building organizations, such as ADPC, to continue their efforts in the region to reduce risk from all disasters, including tsunami.
24. Encourage participation in the PTWS Tsunami Exercise on 17 May 2006.
25. Recommend a follow-up meeting be held in a year's time to report on progress of this Action Plan.

200 The Group **recognized** the International Roundtable as an important step in raising the awareness of countries in the sub-region to tsunami hazards, and **thanked** the government of Malaysia for initiating and helping to organize this important meeting. The Group **encouraged** further proactive mitigation activities, especially by countries with the greatest threats.

201 The Group again **appreciated** the South China Sea Region alert services provided by the Japan Meteorological Agency in coordination with the PTWC, and **thanked** the ITIC for finalizing the Communications Plan to include the new services started in 2006.

4.2 Working Group on the Central America Pacific Coast Tsunami Warning System (CATWS-PAC)

202 This Agenda Item was introduced by the Chair of the Working Group Dr Wilfried Strauch (Nicaragua). The Report of the Working Group is provided in Annex VIII.

203 He reported that ICG/ITSU-XIX Recommendation supported creation of a Regional Central America TWS. In April 2005, the strategy for a Regional Tsunami Warning System (TWS) was adopted by Central American countries and CEPREDENAC (regional intergovernmental agency for disaster reduction). This strategy included the development of a national (local) TWS in each country (to achieve redundancy), the need to ensure close cooperation between these countries, and the on-line exchange of data and warning messages. Two seminars on seismic monitoring were also held in 2005.

204 In early 2006, El Salvador established a national TWS. There are now two countries in Central America with a national TWS, Nicaragua and El Salvador, referring to their National Reports (IOC Documents IOC/PTWS-XX/7.6 and 7.7, respectively) for further details. He indicated that Guatemala would be the possible next candidate for establishing a national TWS. The development of common communications plans is a very critical component of the strategy so that interoperability is maximized for the issuance and understanding of warnings.

205 The Chair of the WG reported scientific institutions in each country are identified as those responsible for seismic monitoring, with government institutions in Nicaragua, El Salvador and Guatemala designated through legislation. He reported also that emergency commissions with communication systems to communities exist. However, there is little knowledge on the occurrence of tsunamis, a lack of knowledge on how to organize tsunami warning, and most severely, little to no funding to carry out this work. In an effort to overcome these problems the Chair of the Working Group visited directors of scientific institutions and Emergency Commissions in Guatemala and Honduras. In addition to discussions of national and regional tsunami warning systems, the GTDB tsunami database was installed and demonstrated to show that warning is possible in many places. During these visits, information on TWS operations in Chile, Peru and Nicaragua were also provided.

206 He reported that presently, there is no real regional coordination, and indicated that he planned to meet with the CEPREDENAC Executive Secretary to discuss the possibility of forming a Steering Committee under the authority of CEPREDENAC in order to raise its priority and awareness.

207 He also reported that at present there are a number of seismic stations in the region (100+ short period stations, 20+ seismic broad band stations, 50+ digital accelerographs), and that some on these stations are connected to the Internet for regular data exchange using FTP (for archiving of

strong events). However, there is no on-line data exchange and rapid automatic processing. To address this problem, workshops on Earthworm software for seismic data acquisition, automatic processing and exchange have been held in Nicaragua, Guatemala, El Salvador and Honduras. Workshops in Panama and Costa Rica are in preparation. At these workshops, Earthworm software is installed and training is provided to local personal. The systems are configured for export of local data to neighbouring countries and IRIS, and for import of data from the greater region.

208 Three additional seismic broadband stations (Nicaragua, El Salvador, Panama) are transmitted on-line to IRIS (via Puerto Rico). Data from Costa Rica is already available, and data from Guatemala (CTBT) and Honduras (USGS) will be available at the end of 2006. More stations will be made available when there is higher bandwidth on the Internet connections in the countries.

209 The Chair of the WG identified that fast determination of the magnitude of strong regional earthquakes is a problem. He reported that there is much interest in TREMORS software, but there are limitations concerning data input. The Chair of the WG has been in communication with the authors of TREMORS regarding a proposal for a new version of TREMORS permitting a broader variety of data input, especially for data coming in via Internet TCP/IP. Another problem is difficulty in determining the magnitude of strong local earthquakes due to saturation. A solution is the installation of virtual networks and the use of distant broadband stations from Central America, northern South America, Mexico, Puerto Rico and USA. Automatic processing of the data will be done using Early Bird software (in process).

210 In Guatemala, slow data communication in the new digital seismic network makes fast evaluation of strong earthquakes impossible, and was thus dissuading Guatemala to become a local TWC. A recommendation has been made to change the data acquisition software at the stations and the type of digital radios at some communication hubs. INETER has provided other radios (WLAN) for testing.

211 Honduras does not have a seismic network at present. Analysis of existing equipment in the country (earlier donations, UNAH, CONAPRED) found nine short period seismometers, one broadband seismometer (which needs to be repaired) and two accelerometers. Three new stations have been installed (preliminary), and additional equipment will be installed in 2006 with help from Nicaragua. One additional broadband station will be installed by USGS as part of the Caribbean TWS.

212 Dr Strauch reported that at the present, there are only two operating gauges on the Pacific coast (NOAA/PTWC). Other stations are not working, such as those installed through the RONMAC project. There has been cooperation with the Regional Water Resources Organization (in Costa Rica) for the repair of two existing instruments (1 in Nicaragua and 1 in El Salvador), and the installation of additional instruments is planned.

213 With regard to the Caribbean system and cooperations, he reported that Nicaragua and El Salvador have participated in the meetings (Barbados, Trinidad), but it is important that all Central American countries participate.

214 He noted that a project proposal was developed and presented to EWC-II (Bonn, Germany) and the regional TWS in Central America has been endorsed by CEPREDENAC & INETER. Equipment was requested (seismic, sea level gauges, GPS receivers, communications equipment), as well as funding for training, risk mapping and outreach. The proposal received good reviews at the conference and was included in the documentation of the conference presented to donor organizations. Proposals and comments from reviewers will be considered in a new version to be discussed with possible donor agencies.

215 The Working Group submitted six recommendations for consideration by the Group:

- Continuation of the Working Group,

- Panama and Honduras become members of ICG/PTWS before the end of 2006,
- Continuation of improvements to seismic and sea level networks,
- Member countries in Central America finalize the setup of National TWS and their integration into a Regional TWS by ICG/PTWS-XXII,
- Member countries to exchange experiences on Tsunami Risk assessment and to undertake tsunami hazard and risk mapping projects in their countries, and
- Assignment of a small amount of funding for a visit by the ICG/PTWS Chairman and/or the ITIC Director for a tsunami meeting in Central America (late 2006 or early 2007).

216 **The Group thanked** the Working Group Chair for the informative summary report of inter-sessional activities. **The Group congratulated** El Salvador for its achievements, and **thanked** Nicaragua for its continued leadership in this region. The Group looked forward to further realizations of cooperation to establish a regional tsunami warning system.

217 **The Group adopted** Recommendation PTWS-XXI.4, to continue inter-sessional activities through the Working Group on the Central America Pacific Coast Tsunami Warning System. Due to the PTWS's limited budget, the Working Group on Programme and Budget regretted that it was not able to support the Working Group's request, but expressed hope that extrabudgetary support would be received during the inter-sessional period that would then provide the requested funding.

4.3 Southwest Pacific

4.3.1 Overview

218 This Agenda Item was introduced by Dr Laura Kong, ITIC Director.

219 This region is very active seismically and is prone to local and sub-regional tsunamis. The 1998 Aitape, Papua New Guinea tsunami that caused 2200 deaths was triggered by a M7.2 earthquake that caused a submarine landslide that generated a tsunami that attached the village of Sissano within tens of minutes. At ITSU-XIX in September 2003, the Working Group on the Tsunami Warning System in the Southwest Pacific and Indian Ocean was formed to evaluate the capabilities of countries in these regions for providing tsunami warning services and to ascertain requirements for such services. In 2004, the ITSU and SOPAC carried out a South Pacific tsunami awareness workshop attended by eight Pacific Island countries, and an action plan was developed to try to help reduce the risk of tsunamis. There was a high recognition of the need for a large effort to focus on tsunami response plans and to plan ahead to decide the response should a warning be received. There was also an effort to improve hazard analysis by using historical data.

220 The Director noted that there have been a number of activities in the past few years with a large focus driven on disaster reduction in a multi-hazard framework. She noted a commitment from SOPAC as a regional entity to work on disaster risk reduction, and reported that Australia planned to upgrade facilities in the South Pacific to help provide real time information.

221 The Delegate of New Zealand, a member of the Southwest Pacific, acknowledged that there were numerous activities going on, and indicated there is potential for even more. He noted that there is a great need for upgrades of instruments to allow real-time data transmission, and also a need for new instruments. New Zealand stated that it would support reformation of the Working Group.

222 The Delegate from Australia supported the re-establishment of the Working Group, reiterating that more work is to be done, and stating that the Working Group can help to facilitate this and provide a framework. He indicated that Australia already supports capacity-building activities with SOPAC, adding that this Working Group could help to focus and identify tsunami activities and priorities.

223 France, Fiji and Samoa also supported the re-establishment of this Working Group. The Director ITIC, also noted that the Pacific Island countries not yet members of ICG/PTWS, should be invited to be part of the Working Group. She encouraged all non-members of the PTWS, to become members of the ICG. The Representative from SOPAC stated its support of end-to-end systems within a multi-hazard approach, and advocated for a holistic approach to disaster risk reduction.

224 **The Group adopted** Recommendation PTWS-XXI.5 to establish the Inter-sessional Working Group on the Tsunami Warning and Mitigation System in the Southwest Pacific Ocean. New Zealand agreed to serve as the Chair and to provide Terms of Reference for the Working Group.

4.3.2 Report of SOPAC on initiatives and inter-sessional activities

225 The Representative from SOPAC provide a summary of the activities of the SOPAC during the inter-sessional period. His Report is provided in Annex X, and as IOC Document IOC/PTWS-XXI/19/

226 SOPAC appreciates the opportunity to report on its current initiatives and activities that relate to building tsunami awareness and mitigation capacity of its member countries. It is both ready and willing to work in partnership with agencies in the region to support and further progress these and related initiatives.

227 He noted that SOPAC is mandated to coordinate disaster risk management activities in the region. SOPAC promotes at the national level an integrated comprehensive approach to the mainstreaming of disaster risk management within the ambit of the regional framework "*An Investment for Sustainable Development in the Pacific Island Countries, Disaster Risk Reduction and Disaster Management, A Framework For Action 2005 – 2015: Building The Resilience Of Nations And Communities To Disaster"*. National development planning is facilitated through a Regional Guideline on Comprehensive Hazard and Risk Management (CHARM). SOPAC works in partnership with the National Disaster Management Offices (NDMOs) who in turn manage the national-level disaster risk management arrangements. On tsunami hazards and relevant warning systems, the NDMOs work together with their respective national Meteorological Services and Seismology/Geology Units within national geological surveys where applicable.

228 SOPAC strongly advocates an integrated all hazards approach. He noted the need for reliable two-way communication systems that can cover vast ocean distances both within and between countries, and particularly to reach small isolated populations on small islands within a vast ocean.

229 He reported that the main activity of the SOPAC Community Risk Programme has been in activities to establish a partnership approach in the development of all hazards early warning systems. Toward these ends, reported that several meetings were sponsored that related to tsunamis. These included *"A Draft Strategy for Enhancing Early Warning for Pacific Island Countries"* in September 2005 to establish a Framework for implementation of the Pacific Plan. This Framework was adopted by the Pacific Island Forum Leaders at the Thirty-Sixth Pacific Islands Forum 25–27 October, 2005 in Madang, PNG, and comprises six themes. One theme concerns effective, integrated and people-focused early warning systems which are based on prior knowledge of the specific hazards and risks, sound scientific and technical monitoring and sustainable warning services, dissemination of timely and understandable warnings, and local knowledge and preparedness to act.

230 He reported that a Strategy was produced and later finalised after deliberations at the 34th SOPAC Governing Council, 19–23 September 2005 in Apia, Samoa. The Strategy expanded on key national activities in the Framework, including priorities to establish and/or strengthen institutional capacities to ensure integrated end-to-end early warning systems, to complete inventories and needs analyses of national early warning systems, to upgrade or redesign existing national forecasting or early warning systems to cater for major hazards, and to develop and implement a comprehensive programme for community awareness and preparedness.

231 With respect to tsunamis, the Strategy specifically aimed to encourage that all PICs receive the Pacific Tsunami Warning Center (PTWC) bulletins, and that they have capability to interpret these bulletins and that they are prepared to respond on a 24/7 basis.

232 He reported that North Pacific Sub Regional "Tsunami Ready" Workshop, Guam 13-15 June 2006 joint partnership between NOAA, SOPAC and ITIC, aimed to bring together National Weather Services staff and emergency managers of the US affiliated Pacific island states and territories in the North Pacific. The workshop is aimed at raising awareness of tsunami risks, existing early warning and response systems for the North Pacific region and to describe various way that tsunami hazards are detected and assessed.

233 He reported that the Pacific Disaster Center, with SOPAC and ITSU, had developed a Pacific Tsunami Awareness Kit containing awareness material that is generic and ready for use in any PIC countries in 2005. A Fiji-adapted version includes local tsunami maps and information has been completed as a pilot. Technical people from Papua New Guinea, Vanuatu and Fiji assisted in sourcing the material.

234 He reported that SOPAC supported Papua New Guinea to participate to the International Training Workshop on Numerical Modeling of Tsunami for Developing Countries in Southeast Asia, the Pacific, and the Indian Ocean, 07-19 November 2005, organized by the ITIC and hosted by the Philippines Institute of Volcanology and Seismology (PHIVOLCS).

235 He reported that SOPAC and SOPAC Member States participated in Pacific Tsunami Workshop, 1-2 May 2006, organized by the Australia Bureau of Meteorology.

236 SOPAC also has contributed its regional perspectives and preliminary data on national capacities to assist in compiling a broad base picture of national capabilities in the region (Annex A of SOPAC Report found in Annex X).

237 Within SOPAC's Ocean and Island Programme (O&IP), the South Pacific Sea Level and Climate Monitoring Project (SPSLCM) continues in Phase IV covering a further 5 years (2006-2011). SOPAC's primary role within the project has been related to technical support in station maintenance and survey activities. SOPAC-O&IP seeks to integrate Project findings into disaster risk management planning and welcomes cross-fertilization through experiences and current initiatives that others can share.

238 He reported that the Pacific Island – Global Ocean Observing System (PI-GOOS) Secretariat is housed at SOPAC and managed by the PI-GOOS Coordinator. In relation to tsunamis, PI-GOOS is now embarking to strengthen integration of its findings into disaster mitigation activities inclusive of tsunami hazards.

239 In closing, he stated that a lot of work, good will, and partnership is still needed to at least implement activities prioritized to date. He reported that a Partnership Network Initiative now exists, coordinated by SOPAC-CRP that has the goal of mainstreaming risk management into national development planning processes. He invited agencies to consider joining the Partnership Network Initiative in support of a collaborative approach at both the regional and national level.

240 The Group **appreciated** the support of SOPAC in recent years to work collaboratively with the ITIC and PTWS to build tsunami preparedness of Pacific Island Countries, and **supported** continued strong and valued partnership to build capacity of people and institutions, and to implement an effective, people-focused tsunami early warning and mitigation system in the Pacific.

5. PTWS STRATEGIC PLAN

5.1 PTWS and IOC's Reorganisation as from 2006

241 This agenda item was introduced by the Chairman.

242 The Chairman reiterated that a new IOC Tsunami Unit in Paris has just been formed, but noted that three of five positions are not permanent and are funded for only a few years. He further noted that since the Indian Ocean tsunami and the consequent formation of ICGs for other oceans, the IOC has asked the ITIC to share its services with the global tsunami warning systems. He expressed concern that this has had the effect of reducing services for the PTWS, and invited comments on the ongoing role of ITIC, as part of the Medium Term Strategy of the PTWS.

243 **The Group noted** that staff in the ICG/IOTWS in Perth are keen to take ownership of their region, but that it will take a few years to become fully functional. In the interim, it **acknowledged** that the IOTWS should rely partly on the services of the ITIC.

244 The ITIC Director reported that prior to 2004, the ITIC only had three personnel (Director, Associate Director, and Information Specialist). However, in response to the 2004 tsunami, the USA has increased its contributed staff to five, but noted that this is still inadequate. She reported that she had proposed to NOAA and the IOC that a ITIC staffing plan requiring 8 -11 persons in order to fully fill the requests for their services. She reported that the IOC Paris has acknowledged that the ITIC is the global expert tsunami resource facility. She reported unfortunately however, that most IOC funds since 2004 have been earmarked for IOTWS, not PTWS.

245 She further reported that the IOC is working with NOAA to complete the secondment of the ITIC Director to IOC, and although established by the IOC in 1965, for the formal establishment of the ITIC as an IOC programme office. She indicated that this will clarify that ITIC is a UN organization rather than a U.S. NOAA centre, and encouraged Member States to contribute to ITIC as a UN organization. The IOC Executive Secretary, Patricio Bernal has stated that ITIC is presently IOC's only long-term commitment to tsunami mitigation since the IOC Tsunami Unit is funded only a few years.

246 **The Group endorsed** the continuation of the ITIC as a PTWS resource, noting with concern the ITIC Director's statement that additional resources are needed in order to sustain itself as a global resource. The Group **supported** the allocation of extra financial support to ITIC to assist with funding more staff.

247 **The Group endorsed** the recommendation that every ICG should have a Regional Tsunami Information Centre (RTIC) to support tsunami warning and mitigation efforts of the region and member states. The Group **agreed** that the IOC should encourage the ICGs to consider establishing RTICs, and that the ITIC should assist where appropriate.

248 **The Group requested** increased cooperation between the ICG/PTWS and other ICGs and invited Working Group Chairs of the other ICGs to participate in ICG/PTWS-XXII in 2007.

5.2 PTWS Communications Plan

249 This Agenda Item was introduced by the Director of ITIC.

250 She referred to earlier Session discussions concerning the Communications Plan. She announced that the updated PTWS Communications Plan is posted to the PTWS web site (Document IOC/PTWS-XXI/12), and includes the description of the NWPTAC. She stated that the posted public Communications Plan does not include Tsunami Warning Focal Point information, and that Member

States should contact the ITIC as the Secretariat directly for this document. She reported that the PTWC is planning to verify their TWFP information during Exercise Pacific Wave 06.

5.3 Working Group Report on the Medium Term Strategy for the PTWS

251 The Chair reported that the Working Group met to consider the work of the Inter- and Intra-sessional Working Groups and to plan the strategy and timetable for the development of the PTWS Medium Term Strategy. The Chair recommended that the Intra-sessional Working Group continue inter-sessionally in order to obtain and consider the recommendations of the PTWS Working Groups, and to report to the Twenty-second Session of the ICG/PTWS in Ecuador in 2007. He noted the importance of building upon and updating the ITSU Master Plan (IOC/INF-1124)

252 **The Group adopted** Recommendation PTWS-XXI.1 Inter-sessional Working Group on the Medium Term Strategy for the Pacific Tsunami Warning and Mitigation System to continue the work to develop a Medium Term Strategy.

253 **The Group requested** the PTWS Working Groups to provide input on its subject area priorities and actions in order to contribute to the PTWS Medium Term Strategy that will be presented at ICG/PTWS-XXII

6. PTWS CAPACITY BUILDING

6.1 ITSU Training Programme

254 This Agenda Item was introduced by Dr Laura Kong, ITIC Director. The ITSU Training Programme (ITP) has been operating since 1974, bringing several people a year to ITIC in Hawaii for training. In 2005, this number was increased and a study tour for 45 people from 19 IOTWS countries was conducted; Indonesia, Malaysia, Singapore, and Thailand are also members of the PTWS and participated to this study tour.

255 She reported that other training activities were carried out or are planned. These include:

ITSU Training Programme (ITP) – Hawaii:

- PTWC Tsunami Warning Centre Operations: 6 persons from Indonesia BMG and Germany, January- February 2006, 2 weeks

ITSU Training Programme (ITP) - International

- Numerical Modelling Training: November 2005, class of 17, held at PHIVOLCS, Philippines with trainers from Japan and Mexico, 2 weeks
- Seismology and Tsunami Warning: May-August 2006, PTWS countries of Indonesia, Thailand, Malaysia, 1 week

256 She reported that IOC activities included capacity building in seismology, tsunami numerical modelling, tsunami warning operations, and alert communications. Cooperative activities were pursued with the US Geological Survey, FSDN/IRIS GSN, AfricaArray, IUGG-Tsunami Commission scientists, PTWC and JMA, and the RANET project. She indicated that TsunamiTeacher was being developed to assist as a electronic training resources tool in this effort.

257 The Delegate from Japan reported that the Japan International Institute of Seismology and Earthquake Engineering (IISEE) will start a new training course on tsunami and earthquake science and tsunami mitigation technologies this fiscal year. He noted that the IISEE has been conducting training since 1962, with over 1200 participants from 95 countries having participated. The new 1-year Masters Degree course will start in late September, and is funded to run for at least three years. Participants will be chosen by their academic qualifications and their statement of interest.

258 He also informed the Group that four BMG staff will come to Japan in June 2006 to focus on warning operation for local tsunamis.

259 The Delegate from France informed the Group that two tsunami training courses, funded by France, were held in French Polynesia in November 2005 (5 persons from Indonesia) and in April 2006 (5 persons from Indonesia).

260 **The Group appreciated** the strong efforts of Member States and the ITIC to conduct trainings, and **called on** the IOC would seek new funding to bolster this important activity. **The Group further asked** Member States to consider providing funding or other support to build the human capacity of PTWS.

6.2 National Assessments

261 This Agenda Item was introduced by Dr Laura Kong, ITIC Director.

262 She reported that that the IOC conducted 16 assessment missions using international experts in the Indian Ocean using a 135-question Questionnaire, and this activity was reviewed at PTWS-XX. She reported that the PTWC Technical Secretary had distributed the Pacific version of the Assessment Questionnaire (Document IOC/PTWS-XXI/Inf. 5) to all PTWS Member States for completion prior to ITSU-XX, but to date had received only eight responses. At PTWS-XX, the Group recommended that countries use the Questionnaire and nearby regional experts to engage in this activity. However, due to funding limitations, assessment missions are presently not possible for the Pacific.

263 The Delegate from Australia reported that it was considering to financially support the SOPAC Pacific Island Country National Assessment Missions, but a decision had not been taken to date.

264 **The Group reiterated** the importance and usefulness of the Assessment to evaluate the preparedness of a country's readiness and to identify gaps to fill and/or strengthen.

265 **The Group encouraged** Member States to take their own initiatives to conduct national assessments based on the PTWS Questionnaire.

7. PTWS INFORMATION SERVICES, EDUCATION AND AWARENESS TOOLS

7.1 Tsunami Newsletter and Tsunami Bulletin Board

266 This Agenda Item was introduced by Dr Laura Kong, ITIC Director. She reported that the ITIC Tsunami Newsletter is now published quarterly, and continues to focus on the activities of the PTWS, and on summarizing tsunami events. She asked Member States to consider contributing regularly to the Newsletter through submission of articles for inclusion. She indicated that current resources cannot support a Global Tsunami Newsletter, and requested input from Member States on this policy.

267 **The Group agreed** that the newsletter plays an important role in the PTWS, and that the current publication frequency of four issues per year is satisfactory.

268 **The Group agreed** to ask the IOC Tsunami Unit in Paris to produce a newsletter covering global tsunami issues and news.

7.2 TsunamiTeacher and Other Resources

269 This Agenda Item was introduced by Dr Laura Kong, ITIC Director. She presented a preview of the near-final version of TsunamiTeacher. She indicated that final editing and review was being carried out, and anticipated a final version (IOC/Manuals and Guides, 47) in June 2006.

270 The Director also noted the completion of a Pacific Tsunami Awareness Kit through a collaborative effort of Pacific Islands, SOPAC, ITIC, PTWC, and led by the Pacific Disaster Center. She indicated that Fiji was selected for the 1st customized Kit.

271 **The Group thanked** the ITIC for taking on this exhaustive compilation as it constitutes an important and significant contribution for a global implementation, and is a means by which to share the Pacific experience with the world. **The Group requested** that the final version be broadly distributed to PTWS Member States. **The Group further noted** that need to provide translated versions, especially in Spanish and French in order to meet the needs for the majority of the countries in the Pacific.

7.3 Publications

272 This Agenda Item was introduced by the ITIC Director. She reported that a number of ITIC Awareness materials were updated in 2005 and 2006. She noted that the ITIC has compiled a small number of basic tsunami awareness materials to support the needs of government agencies, emergency managers and educators globally. She indicated that many of the materials were originally developed to support countries of the Pacific Tsunami Warning and Mitigation System, and were then revised to support and address a global community. A number of additional materials were developed in 2005 and 2006 after the 26 December 2004 Indian Ocean tsunami. She indicated that Tsunami, The Great Waves, Tsunami Warning! and the Tsunami Awareness Poster are provided in formats to allow them to be modified to meet the needs. Upon modification, she asked that electronic and hard copies be provided to the ITIC to enable the sharing of awareness materials with others. She informed the Group that all files are available by CD from ITIC on request, or available for download from the ITIC web site at http://ioc3.unesco.org/itic/categories.php?category_no=75, http://www.tsunamiwave.info under Products and Services, Public Info Tools and Products, or from the PTWS web site (Awareness//Education Materials) at http://ioc3.unesco.org/ptws/

273 The materials compiled by the ITIC include:

- Tsunami, The Great Waves, IOC Brochure 2006-2, ITIC, being revised, 2006
- Tsunami Glossary, IOC Information Document No. 1221, ITIC, Revised January 2006
- Tsunami Warning! Children's Cartoon Book, IOC Information Document No. 1223, ITIC, Revised 2005
- Tsunami Awareness Posters (11x17, 17x22 inch), ITIC, 2005, 2006
- Tsunami Safety Flyers (8.5x11 inch), ITIC, being revised, 2006
- Surviving a Tsunami - Lessons from Chile, Hawaii, and Japan, USGS, Revised 2005, Spanish version being translated in 2006
- EQ and Tsunami Textbooks (Color), SHOA/IOC/ITIC, 1997, revised 2003
- ADRC – ITIC Grades 4-6 Curricula and Teacher's Guide, Thailand example, currently being completed, 2006
- IOC TsunamiTeacher, pre-Live version available, currently being finalized, in DVD format, IOC Manuals and Guides, 47
- U.S. National Tsunami Hazard Mitigation Program (NTHMP) – Selected Interviews, 2005, in DVD format
- Hawaii Tsunami Warnings 1986, 1994, version 2, November 2004, in DVD format (News clips of actual statewide warnings.)

- Save Your Lives from Tsunami!, Japan Meteorological Agency (JMA), 2004, in CD format

274 Regarding the information sharing through web sites, the ITIC Director reported that during 2006, the ITIC enabled a PTWS web site in similar format and design to the web sites of the other IOC ICGs. The PTWS web site URL is http://ioc3.unesco.org/ptws/. The ITIC tsunami information web site continues to be found at http://www.tsunamiwave.info under the ITSU banner where ITIC is the Information Resource of IOC ITSU (International Tsunami). Later in 2006, the IOC will enable a global tsunami web site, at which time the contents of the ITIC and PTWS web sites will be transferred.

275 **The Group commended** the ITIC for its efforts to meet the needs of the global tsunami community, but **reiterated** the need to provide materials widely to PTWS Member States as tsunamis are most frequently observed in the Pacific.

8. OTHER REGIONAL TSUNAMI WARNING AND MITIGATION SYSTEMS

8.1 Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWS)

276 This Agenda Item was introduced by Dr Jane Cunneen from the ICG/IOTWS Secretariat.

277 The IOTWS is designed to be a single system with participation by all Indian Ocean countries. The Japanese Meteorological Agency and the Pacific Tsunami Warning Center are currently providing an interim tsunami information system. 7x24 National Tsunami Focal Points have been identified in 28 nations. Governance is implemented through the UNESCO/IOC ICG/IOTWS. Joint United Nations implementation is coordinated with IOC, WMO, ISDR, UNDP, and UNESCAP.

278 Activities in 2005 included National Assessment Missions (May-Sept); formal establishment of the ICG/IOTWS with its Secretariat hosted by Australia and located in Perth, Australia in June 05; conduct of two ICG/IOTWS Sessions in August and December in 2005 with ICG/IOTWS-III planned for July-August 2006 in Bali, Indonesia, and the establishment of six Working Groups. More information is found at http://www.ioc3/unesco.org/indotsunami/

8.2 Intergovernmental Coordination Group for Tsunami and Other Coastal Hazards Warning System for the Caribbean and Adjacent Regions (ICG/CARIBE-EWS)

279 This Agenda item was presented by the Delegate from Nicaragua, Dr Wilfred Strauch.

280 The First Session of the ICG/CARIBE-EWS was conducted 10-12 January 2006 in Bridgetown, Barbados. The meeting was attended by 70 participants from 26 countries in the Caribbean region, six organisations and five observers. The Session endorsed 16 Recommendations as its Action Plan. During the Session, four Inter-sessional

281 Working groups were established:

- WG1 Hazard and risk assessment and research
- WG2 Monitoring and detection systems
- WG3 Warning, dissemination and communications
- WG4 Preparedness, readiness and resilience

282 The Interim Technical Secretariat, currently provided by the IOCARIBE Secretariat, strongly requested to Member States to designate official Tsunami Warning Focal Points.

283 PTWC is providing interim tsunami warning advisories for the whole Caribbean region until a Caribbean Tsunami Warning Centre is established. Member States noted it to be important to include island nations, and to look at both parallel and unique needs. People in the region are very aware of tsunami risks, because of the broad and strong information provided by its Emergency Managers.

284 ITIC is providing interim Tsunami Information Services. The governments of Barbados and Venezuela indicated interest in supporting a regional Caribbean Tsunami Information Centre, and planned to contact the ITIC for further information on requirements, functions, and activities.

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

285 The Agenda Item was presented by the Delegate from France, Dr François Schindelé.

286 He reported that the First Session of the Intergovernmental Coordination Group for the Tsunami Early Warning and Mitigation System in the North Eastern Atlantic, the Mediterranean and connected Seas (ICG/NEAMTWS), established by the IOC Assembly during its 23rd Session in June 2005, through Resolution XXIII-14, took place in Rome 21-22 November 2005.

287 The meeting was attended by more than 150 participants from 24 countries, 13 organizations and numerous observers. Reports from national, regional and international organizations were presented on the development of a tsunami and multi-hazard regional early warning system and provided the basis for working group discussions on the establishment of such a system in the North Eastern Atlantic, the Mediterranean and connected Seas.

288 The Tsunami Warning System will be based on existing seismographic and sea level networks, with appropriate upgrade to real-time operation. Several national and local warning systems under development will be fully integrated into this initiative. Nations committed themselves to work towards upgrading legislation and existing detection systems, and to develop integrated national emergency preparedness and awareness plans.

289 The ICG nominated Italy as Chair of the ICG, a position that will be served by Prof. Stefano Tinti for two years assisted by two Vice-chairs, Morocco and Greece; positions that will be served by Dr Azelbarab El Mouraouah, and Dr Gerassimos Papadopoulos,

290 During the inter-sessional period four working groups will address issues concerning the formulation and operationalization of a multi-hazard early warning system for the North Eastern Atlantic, the Mediterranean and connected seas:

- Hazard assessment, risk and modelling
- Seismic and geophysical measurements
- Sea level measurements
- Advisory, mitigation and public awareness

291 The ICG will work towards the formulation of a complete plan of action by December 2006, including the implementation of an initial operational system by December 2007. ICG/NEAMTWS-II will be held 22-24 May 2006 in Nice, France.

292 The Delegate from the USA noted that at ICG/NEAMTWS-I, it was observed that the existing expertise in geohazards and sea level monitoring are not well coordinated and less familiar with “real-time” data for warnings, and asked for comment from the PTWS on the opportunities for the ICG/PTWS to work more closely with the ICG/NEAMTWS, especially on the lessons it has learned which can help other regions that are developing systems

293 Dr. Schindelé agreed that the existing NEAMTWS community is research-driven and that considerable attention to developing the warning centers and information sharing could benefit from working with the PTWS as well as with the Caribbean Tsunami Warning System because of the common sub-regional tsunami threat in both the Mediterranean and the Caribbean.

8.4 Framework for the Global Tsunami and other Ocean-Related Hazards Early Warning System

294 This Agenda Item was summarized by the Technical Secretary. She informed the Group that through Resolution IOC/XXIII-15, the IOC Assembly at its Twenty-Third Session decided to support the establishment of a framework for the global tsunami and other ocean-related hazards early warning system, and had instructed the Executive Secretary to establish an ad hoc Working Group on Global Tsunami and other Ocean-related Hazards Early Warning and Mitigation Systems (GOHWMS).

295 The ad hoc Working Group is to be composed of the Chairpersons of IOC Intergovernmental Coordination Groups for regional tsunami early warning and mitigation systems, and those of relevant Subsidiary Bodies (GOOS, JCOMM, IPHAB, IODE). Relevant organizations of the UN system and other programmes are also invited to participate.

296 The first meeting of this Working Group will be held 24 June 2006 at UNESCO headquarters to discuss issues of feasibility, sustainability and governance of such a global early warning and mitigation system and to adopt its terms of reference.

297 ICG/PTWS will be represented at this meeting by its Vice-Chairman, Mr Fred Stephenson.

8.5 Co-operation with other ICGs and ICG Working Groups

298 This agenda item was introduced by the Chairman, Dr Rodrigo Nuñez. The Chairman commented that other regional systems are being immediately developed since 2005 in response to the 2004 Sumatra Tsunami. He noted that the PTWS and its Member States have already contributed strongly to the development of these systems, but expressed concern that to date there was no formal coordination mechanism for experience and best practice sharing, and that without this, confusion, inconsistency, and non-interoperability between regions could easily result. He encouraged ICG/PTWS cooperation with other ICGs, and asked ICG/PTWS members to represent the PTWS at other meetings if no ICG/PTWS Officer could be present.

299 **The Group recognized** the importance of interoperability, and **requested** especially Member States which have borders on two oceans or two ICGs to actively participate in both ICGs where possible so as to ensure that systems are developed in coordination. **The Group supported** the attendance of a PTWS representative, either an Officer or Member State, to the ICGs of other regions where funding permits.

9. EXISTING PARTNERSHIPS AND OPPORTUNITIES FOR NEW ONES

9.1 Co-operation with the IUGG Tsunami Commission

300 This Agenda item was presented by Dr Alexander Rabinovich on behalf of Dr Kenji Satake, Chairman of the IUGG Tsunami Commission (IUGG-TC). Dr Rabinovich noted that there continues to be active cooperation between the IUGG-TC and the ICG/PTWS, as well as with the other recently formed tsunami warning and mitigation systems. He reminded the Group that at the last IUGG-TC meeting in Chania, Greece (June 2005), Working Groups were formed to look at (1) the numerical simulation of tsunamis, and (2) sea level records (global) for the study of the 26 December 2004 tsunami. The results of these Working Group investigations are relevant to the ICG/PTWS.

301 Dr Rabinovich also informed the Group that topical issues are now in preparation by the Bulletin of Seismology Society of America, and Pure and Applied Geophysics, with both edited by Dr Satake. The latter issue will include several papers presented at the pre-ICG/PTWS-XX Session in Chile in 2005.

302 The Chairman mentioned that one of the Terms of Reference of Working Group 3 is "to review details on models that are currently used or in development." He indicated that IUGG-TC advice on the best or most appropriate models would be appreciated. He expressed the continued interest of the PTWS for cooperative IUGG-TC and ICG/PTWS meetings as this heightens tsunami awareness in the country and region where ICG's are held. Dr Rabinovich indicated that he would communicate this information to the Chairman IUGG-TC and enquire about future plans for IUGG-TC symposia and opportunities for co-operation with the ICG/PTWS.

303 **The Group requested** the support and advice of IUGG-TC to provide technical information and recommendations to the requests of PTWS Working Group 3 for ICG/PTWS-XXII.

304 **The Group agreed** to investigate the possibility of coordinating the timing of future IUGG-TC symposia to be back-to-back with ICG/PTWS meetings.

9.2 Co-operation with World Data Center-A, Solid Earth Geophysics – Tsunamis

305 The ITIC Director summarized this Agenda item, referring to the discussions under Agenda item 3.11 for more details on the merging of the two existing databases into a consolidated, quality-control historical tsunami database.

306 She additionally reported that the International Tsunami Information Centre and WDC-A/NOAA NGDC are working closely to provide tsunami travel time methodology to national authorities responsible for tsunami warning and emergency response.

307 In 2005, the ITIC purchased the license enabling broad distribution of Tsunami Travel Time (TTT) software developed by Dr Paul Wessel (University of Hawaii), with the goal of developing and providing a stand-alone CD-ROM product and as a plug-in to the WDC-A/NOAA online interactive hazard maps. This software is the same as that used by the Pacific Tsunami Warning Center to estimate tsunami travel times, and was the software used to provide the tsunami travel time scenarios for Exercise Pacific Wave 06.

308 To test the results of the software using different bathymetric resolutions, the WDC/NOAA produced tsunami travel-time maps for major teletsunamis in the Atlantic, Indian and Pacific Oceans. These maps are now accessible from WDC/NOAA's website (http://www.ngdc.noaa.gov/seg/hazard/tsu_travel_time.shtml). Each map is linked to search results for the event in the NGDC online digital historical tsunami database. Data for these source events have been verified, as well as the travel times for the associated run-ups (by comparison of the observed vs. modeled travel times.)

309 ITIC and WDC-A have been able to combine their resources and expertise to great advantage, and will continue to cooperate on areas of mutual benefit.

9.3 Co-operation with SOPAC

310 The Chairman acknowledged the support provided by SOPAC in coming to the meeting, and their important role in coordinating the efforts of Pacific Island countries. The ICG/PTWS is keenly aware that small countries throughout the world are faced with significant challenges in the management of tsunami risks. SOPAC reported under Agenda 4.3 a forward-looking plan to establish and sustain a regional network, to improve regional cooperation, coordination and collaboration, to

reduce duplication of effort, and to ensure assistance is built on the efforts and experience of each other, and with the goal of investing so as to promote sustainable development.

311 The Representative from SOPAC recounted that SOPAC had collaborated with the PTWS and its ITIC already in a number of activities over the last few years in order to increase tsunami awareness. He stated that SOPAC looked forward to continuing a productive partnership with the PTWS and its Inter-sessional Working Group in order to build tsunami preparedness of its Member States.

312 The Delegate from the USA supported SOPAC's remarks that small island nations have unique geophysical and marine hazards, and capacity development challenges, He called on IOC and the ICG/PTWS to facilitate opportunities for Small Island Developing States of all ICGs (PTWS, CARIBE-EWS, IOTWS) to share best practices. He encouraged the IOC to consider convening a Small Island Nations side meeting at the next CARIBE-EWS meeting to focus discussion on the special needs of island nations. He also asked the Group and Member States to consider a resolution for the IOC Executive Council that recognizes the unique issues of small island countries and calls for the ICGs and IOC Member States to facilitate coordination.

313 The ITIC Director supported the USA intervention and further recommended that any initiative include the islands in the Indian Ocean. She commended SOPAC in taking strong leadership role to develop a regional strategy and needs requirements for early warning, and stated that the ITIC looked forward to continuing this relationship and to working with all countries.

314 **The Group appreciated** the continued support of the SOPAC Secretariat to work in partnership with the PTWS, and **supported** the continuation and expansion of cooperation efforts to strengthen capacities of Pacific Island nations to address tsunami hazards in their countries.

315 **The Group urged** the small island nations in the Pacific and the Caribbean regions to exchange experiences in hazard warning and mitigation, and encouraged participation in future ICG meetings.

9.4 Co-operation with WMO

316 The Agenda item was presented by Dr Ray Canterford on behalf of the World Meteorological Organization. He discussed cooperation with WMO and contributions to the Tsunami Early Warning System

317 The WMO has a long history of cooperation and data sharing through its global networks. This is a very strong and well-established arrangement. The WMO Secretariat is based in Geneva, Switzerland and comprises 187 Member States. It included eight technical commissions and ten programmes, and oversees the coordination and implementation of a wide range of equipment and communication systems, including satellites, drifting buoys, balloons and aircraft. Much work has been done to develop meteorological models and this information is shared around the world. The WMO has strong partnerships with UNESCO-IOC and ISDR, and with other agencies.

318 WMO's contribution to the Tsunami Warning System in the Indian Ocean includes GTS, as well as a range of other activities including support for regional tsunami centres, enhancement of multi-hazard response systems etc. As the National Meteorological Services of IOTWS countries carry out 24/7 operations, they have been designated to be the Tsunami Warning Focal Points in almost all countries of the ICG/IOTWS.

319 After the Indian Ocean tsunami, several steps were taken to improve the WMO's GTS system, which includes a strong linkage of satellite and local networks. GTS technical improvements included upgraded links to regional telecommunication hubs and national meteorological centres.

Some operational tests of the Indian Ocean message system have been conducted, and it appears to be working well. Several additional GTS upgrades are underway.

320 The Director of ITIC noted that WMO have been working on aspects of multi-hazard. She indicated that the ITIC has been in contact in order to discuss cooperation on training so as to reach the most appropriate sector for tsunami warnings. She noted that most of the eastern and southern Pacific TWFP are national meteorological services, but that this was not the case for Central and South America. In Central America, TWFP are currently technical scientific monitoring agencies, and in South America, TWFP are the naval hydrographic services.

321 **The Group appreciated** the essential contributions of the WMO's communications infrastructure for the transmission of timely tsunami warnings and sea level data for tsunami monitoring, and for the important roles the national meteorological can have in tsunami alerting and building preparedness within their countries.

322 **The Group welcomed** continued and increased cooperation between the IOC and WMO in order to build robust and reliable tsunami warning and mitigation systems in the Pacific, and globally.

9.5 Co-operation with JCOMM

323 The Agenda item was presented by Dr Peter Dexter, as the President of the IOC-WMO Joint Technical Commission on Marine Meteorology (JCOMM).

324 Dr Dexter informed the Group that JCOMM is one of the eight technical commissions of WMO, working closely with the oceanographic community. This is a joint effort between the WMO and IOC. He reported that JCOMM is an IOC Project, and thus is similar in status in the IOC to the IODE in Belgium. JCOMM consists of an intergovernmental body of technical experts, and functions at all levels, though most of the work is regional rather than local. JCOMM integrates marine observing, data management and service systems, acting as a coordination mechanism in which programme implementation is through national agencies. JCOMM has three programme areas that are overseen by a coordination group and participated to by a number of specialist teams, and a management committee.

325 Dr Dexter gave an update on the status of the Argo Observing System, which has now launched 1250 surface drifters. The implementation plan is a multi-year phase plan, hoping to be fully implemented by about 2010. JCOMMOPS is an important part of the system and conducts system-wide monitoring and performance reporting. Data management activities are being coordinated more closely with IODE and include implementation of pilot projects. He reported that JCOMM is also involved in the following activities related to tsunamis: coordination on safety within the Observations Programme, consideration of supporting the international tsunameter partnership, especially data communications within the Data Buoy Program (DBCP), and vandalism of marine platforms working with platform operators also within the DBCP.

326 Dr Dexter informed the Group that the Global Sea Level Observing System (GLOSS), which has already played a major role in upgrading GLOSS sea level stations in the Indian Ocean and Southeast Asia to support tsunami monitoring, is part of JCOMMOPS of JCOMM. Within the Data Management Programme Area, he reported that JCOMM members are working on data standards and codes for improving sea level data sharing over the GTS in both the Indian and Pacific Oceans, in response to a question from the Vice-Chair of ICG/IOTWS Working Group 2 (Sea Level), Mr Bernard Kilonsky (GLOSS).

327 The PTWS Chair, Dr Rodrigo Nuñez, reiterated that the ICG/PTWS should become aware of and take advantage of cross-agency and ICG cooperation in order to implement a better system in the Pacific.

328 **The Group requested** cooperation from JCOMM in developing strategies to minimise vandalism of sea level buoys.

329 **The Group appreciated** the essential contributions of the WMO's communications infrastructure for the transmission of timely tsunami warnings and sea level data for tsunami monitoring, and for the important roles the national meteorological organizations can have in tsunami alerting and building preparedness within their countries.

330 **The Group welcomed** continued and increased cooperation between the ICG/PTWS and WMO in order to build robust and reliable tsunami warning and mitigation systems in the Pacific, and globally.

9.6 Co-operation with ISDR

331 The ITIC Director introduced this Agenda item.

332 She reported that the ITIC continued to build collaborative working relationships with the ISDR Platform for the Promotion of Early Warning (PPEW) and ISDR Public Communications Officer, and has discussed similar activities that can extend into the Pacific. Currently, the ITIC is working with the ISDR on the following projects:

- Media awareness building with Asian Broadcasting Union and Japan NHK (focus on Indonesia and Thailand, which are also PTWS members);
- Participation in ESCAP- ISDR Disaster Preparedness and Mitigation Meeting, June, 2006;
- Animated computer game on disaster reduction involving the building of communities and the consequences of design and policy decisions when a natural disaster hits (e.g., tsunamis, earthquakes, and volcanic eruptions).

333 The Delegate from Australia advised that in a recent visit to ISDR in Bonn, Germany, members of the Platform for the Promotion of Early Warning indicated their strong support for the integration of disaster management considerations, including community awareness and education, into tsunami warning system implementation. He also recognised and applauded the efforts of the ITIC to collaborate with ISDR on tsunami warning matters.

334 **The Group agreed** with the need to increase tsunami preparedness at all levels from tsunami warning to community preparedness, and **endorsed** the continued and increased cooperation between the ICG/PTWS and ISDR in order to build tsunami resiliency of all Pacific nations.

10. PROPOSALS FOR FUTURE PROJECTS

335 No proposals were made for future projects.

11. REPORT OF THE SESSIONAL WORKING GROUPS

336 Sessional Working Group Reports were made during their respective topical Agenda item discussions. Specifically, the Working Group on Programme and Budget reported in Agenda item 15, the Working Group on Medium Term Strategy for the PTWS in Agenda item 5.3, and the Working Group on Southwest Pacific Tsunami Warning and Mitigation in Agenda item 4.3

12. OTHER BUSINESS

337 The Chairman introduced the topic of GEO and GEOSS for discussion by the Group, noting that the seismological and sea level networks are already contributing to the sharing and multi-use of data streams. He noted that within GEO, a Tsunami Working Group had been established, but stated

that he was not aware of its activities. He inquired to Member States to consider whether the PTWS should play a more active role to the Tsunami Working Group.

338 **The Group requested** the IOC Tsunami Unit to provide an update on GEOSS at ICG/PTWS-XXII in order to enable the Group to consider its applicability to the PTWS.

339 The Technical Secretariat informed the Group that she had received a request from the IOC Executive Secretary to consider issuing a press release for this Session, noting especially the occurrence of the 3 May 2006 earthquake and tsunami off Tonga during the Session. The Executive Secretary offered some suggestions for topics to address.

340 After much discussion on the advantages and disadvantages of such a statement, **the Group decided** not to take action to develop a response due to the non-availability of complete information on the Tonga event at this early stage and considering that there was not enough time in the Session to provide for a proper discussion and drafting of such a statement.

13. PROGRAMME AND BUDGET FOR 2006-2007

341 The Technical Secretary reminded the Group that the ICG/PTWS budget is currently under the approved 2006-2007 biennium UNESCO Regular Programme funding made available for ITSU. As such, the goal of the Sessional Working Group on "Programme and Budget 2006–2007", established under Agenda item 2.5, was to review and revise accordingly the ICG-PTWS-XX budget based on the decisions, recommendations, and priorities of ICG/PTWS-XXI. She thanked the governments of the Republic of Korea, France, and Canada for extrabudgetary contributions in 2006, and looked forward to further contributions of Australia, Canada, Chile, Ecuador, and France during the 2006-2007 biennium.

342 The Working Group Chair reported that it had updated the detailed work plan based on the 2006 budget, and reallocated the available resources for 2007. He noted that the 2007 ICG/PTWS budget request totalled US $91,000, but that the UNESCO regular programme allocation was informed to be only US $29,000 leaving unfunded an amount of US $62,000. In 2006, the PTWS shortfall amounted to US $48,000.

343 The Chairman appealed to Member States to strongly consider extra-budgetary support through contributions to the IOC Trust Fund for use by the ICG/PTWS in order to reach the minimum level needed to sustain the current levels of tsunami mitigation activities in the Pacific.

344 **The Group adopted** Recommendation PTWS XXI.3.

14. DATES AND PLACES FOR ICG/PTWS-XXII AND ICG/PTWS-XXIII

345 The Technical Secretary introduced this Agenda item and noted that the Secretariat and Chairman had received an offer in writing from the Instituto Oceanográfico de la Armada (INOCAR), as the Ecuador Tsunami National Contact, to hold the ICG/PTWS-XXII in October 2007 in Guayaquil. **The Group decided** to organize its Twenty-second Session in October 2007 in Ecuador.

346 **The Group agreed** to return to the biennial format of the ICG/PTWS Sessions starting every from 2007, noting that the ICG/PTWS-XXI was organized as a extra-ordinary session in response to the importance of evaluating its present performance and need to identify areas for strengthening.

347 During the Session, the Government of Samoa offered to host the Twenty-third Session in 2009, noting the heightened awareness of the tsunami hazard in the Southwest Pacific in recent years. **The Group appreciated and decided** to accept the generous offer by Samoa to host ICG/PTWS-XXIII in 2009.

348 The Group was then addressed by the Honourable Greg Hunt, Australia Secretariat to the Minister for Environment and Heritage. He recalled that the 2004 Indian Ocean Tsunami to be a wake up call to people around the globe, and stated that within his country, $69 million dollars has been allocated to develop the Australian tsunami warning and mitigation system. This includes $10 million to the Pacific programme for technology, training and other needs to help Pacific Island nations face these hazards. He emphasized a sense of urgency to improve the system in this area, especially to ensure that every island nation in the Southwest Pacific is part of the PTWS, and urged nations that are not yet members of the PTWS to join. In closing, he thanked the Chairman and all the Delegates from all countries here today for their work and their contribution, and their commitment to develop a system that will outlive all of us and save lives in the future.

15. ADOPTION OF ACTION ITEMS AND RECOMMENDATIONS

349 **The Group reviewed** the draft Action Items and Recommendations of the Session and **adopted** them as herein presented. **The Group requested** the ICG/PTWS Chairman and the IOC Technical Secretary to prepare an Action Sheet on the ITSU-XX and PTWS-XXI decisions by the end of December 2006, and to make it available to all Member States and PTWS-XXI participants through the ICG/PTWS web site.

350 **The Group requested** its Chair to report on the proceedings of the ITSU-XX and PTWS-XXI Sessions to the Thirty-ninth Session of the IOC Executive Council, 21–28 June 2006, UNESCO Headquarters, Paris.

351 **The Group noted** that there was only a short preparation time before IOC/EX-XXXIX, and **approved** the submission of an PTWS-XXI Executive Summary prepared by the Technical Secretary and the Chairman for IOC/EC-XXXIX, containing a concise summary of its work, including major achievements, action items, and problems during the inter-sessional period, and accompanied by the Group's approved recommendations and their financial implications.

352 The Technical Secretary recalled that for ITSU-XX, the presenters of introductions of agenda items, reports on progress and other text with an informative nature, had submitted written summaries for inclusion in the Summary Report, and that the Group would not formally adopt these during the Session. The Chairman thanked the presenters for providing summaries. He reminded the Group of the importance of submitting Session Working Documents and presentation summaries prior to the Session in order to achieve a timely completion of the Summary Report.

353 **The Group agreed** to continue this practice, and on the high value of a Summary Report in the format of past ITSU Summary Reports. **The Group requested** the Summary Report to be completed by the Technical Secretariat in cooperation with the Chairman afterward.

354 **The Group further requested** the Secretariat to continue preparing a detailed Annotated Agenda for future Sessions, as had been done for the current Session.

16. CLOSURE

355 The Chairman declared the Session closed at 17h50 on Friday, 5 May 2006.

ANNEX I

AGENDA

1. OPENING

2. ORGANISATION OF THE SESSION
2.1 ADOPTION OF THE AGENDA
2.2 DESIGNATION OF THE RAPPORTEUR
2.3 SESSION TIMETABLE AND DOCUMENTATION
2.4 LOCAL ARRANGEMENTS
2.5 ESTABLISHMENT OF SESSIONAL WORKING GROUPS

3. PROGRESS IN PROGRAMME IMPLEMENTATION
3.1 REPORT OF THE CHAIRMAN ON INTER-SESSIONAL ACTIVITIES
3.2 NATIONAL REPORTS
3.3 ITIC DIRECTOR'S REPORT
3.4 PTWC DIRECTOR'S REPORT
3.5 JMA DIRECTOR'S REPORT
3.6 IOC TSUNAMI COORDINATION UNIT
3.7 RECRUITMENT OF NEW MEMBERS TO THE PTWS
3.8 "EXERCISE PACIFIC WAVE '06" TASK TEAM REPORT
3.9 TONGA EARTHQUAKE AND TSUNAMI, 3 MAY 2006
3.10 SEISMOLOGICAL OBSERVATIONS AND OTHER RELATED MATTERS
3.10.1 REPORT OF INTER-SESSIONAL MEETING OF ICG/PTWS WORKING GROUP 1 ON SEISMIC MEASUREMENTS, DATA COLLECTION AND EXCHANGE
3.10.2 GLOBAL SEISMOGRAPHIC NETWORK
3.10.3 TSUNAMI OBSERVATIONS ON SEISMIC STATIONS
3.11 SEA LEVEL OBSERVATIONS AND OTHER RELATED MATTERS
3.11.1 REPORT OF INTER-SESSIONAL MEETING OF ICG/PTWS WORKING GROUP 2 ON SEA LEVEL MEASUREMENTS, DATA COLLECTION AND EXCHANGE
3.11.2 GLOSS REPORT
3.11.3 DART SEA LEVEL NETWORK REPORT
3.11.4 XML SEA LEVEL STATION REPORT
3.12 TSUNAMI HAZARD IDENTIFICATION AND RISK ASSESSMENT AND OTHER RELATED MATTERS
3.12.1 REPORT OF INTER-SESSIONAL MEETING OF ICG/PTWS WORKING GROUP 3 ON SEA LEVEL MEASUREMENTS, DATA COLLECTION AND EXCHANGE
3.12.2 INTEGRATED TSUNAMI DATABASE PROJECT (ITDB) REPORT
3.13 RESILIENCE BUILDING AND EMERGENCY MANAGEMENT AND OTHER RELATED MATTERS
REPORT OF INTER-SESSIONAL MEETING OF ICG/PTWS WORKING GROUP 4: RESILIENCE BUILDING AND EMERGENCY MANAGEMENT
3.14 INTEROPERABLE TWS AND OTHER RELATED MATTERS
REPORT OF INTER-SESSIONAL MEETING OF ICG/PTWS WORKING GROUP 5 ON INTEROPERABILITY AND REGIONAL, SUB-REGIONAL AND NATIONAL TSUNAMI WARNING AND MITIGATION SYSTEMS IN THE PACIFIC

4. SUB-REGIONAL PACIFIC TSUNAMI WARNING AND MITIGATION SYSTEMS

4.1 NORTHWEST PACIFIC AND SOUTH CHINA SEA REGIONS

4.2 WORKING GROUP ON THE CENTRAL AMERICA PACIFIC COAST TSUNAMI WARNING SYSTEM (CATWS-PAC)

4.3 SOUTHWEST PACIFIC

4.3.1 OVERVIEW
4.3.2 REPORT OF SOPAC ON INITIATIVES AND INTER-SESSIONAL ACTIVITIES

5. PTWS STRATEGIC PLAN
5.1 PTWS AND IOC'S REORGANISATION AS FROM 2006
5.2 PTWS COMMUNICATIONS PLAN
5.3 WORKING GROUP REPORT ON THE MEDIUM TERM STRATEGY FOR THE PTWS

6. PTWS CAPACITY BUILDING

ANNEX II

LIST OF RECOMMENDATIONS

RECOMMENDATIONS

RECOMMENDATION PTWS-XXI.1

INTER-SESSIONAL WORKING GROUP ON THE MEDIUM TERM STRATEGY FOR THE PACIFIC TSUNAMI WARNING AND MITIGATION SYSTEM

The Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System,

Recalling the devastating impact of the Indian Ocean tsunami of 26 December 2004,

Stressing the need for the UN agencies and other partners to work together, reinforcing each other's core areas of expertise,

Noting with appreciation the excellent collaboration between IOC, WMO and ISDR in the establishment of the Indian Ocean Tsunami Warning and Mitigation System,

Recognizing the new context of an end-to-end framework and taking into consideration the need to further develop and maintain national systems in a multi-hazard context,

Decides to continue the inter-sessional working group for the development of a medium term strategy for the Pacific Tsunami Warning and Mitigation System, established by Resolution ITSU-XX.2,

Decides that the Group will be composed of the ICG/PTWS Officers and Working Group Chairs, and will be chaired by the ICG/PTWS Chairman. Other members may be added at the discretion of the Group's Chair.

Decides further that the Group will work by e-mail correspondence,

Requests the Group to take into consideration:

(i) the work of the inter-sessional working groups on seismic measurements, data collection and exchange; sea level measurements, data collection and exchange; tsunami hazard identification and characterization; resilience building and emergency management; and interoperability of region, sub-regional and national tsunami warning systems in the Pacific, established by the ICG/PTWS and other ICGs, as well as any cross-cutting matters between the ICGs;

(ii) the ITSU Master Plan;

(iii) capacity building requirements of new and existing Member States of the Pacific Tsunami Warning and Mitigation System, as revealed by relevant assessments or as indicated by the Member States,

(iv) the WC/ATWC as a backup to the PTWC

Also, as the May 4, 2006 earthquake near Tonga has so dramatically demonstrated, the medium term strategy for the ICG/PTWS must focus on many aspects of communication. This focus should include, but not be limited to:

(i) Ensuring that messages issued by the Warning Centres are concise and unambiguous (WG1, WG5);

(ii) Identifying and promoting best practices concerning communication strategies for getting messages from National Warning Centres to the regions and communities within each country (tsunami integrated preparedness). This work should recognize the importance of capacity building and a multi-hazard approach (WG1, WG4);

(iii) Developing communication strategies for working with the international, national and local press (WG4, Medium Term Strategy WG);

(iv) Promoting inter-operability with the other Tsunami Warning Systems (WG5, Medium Term Strategy WG);

(v) Moving beyond the "pebble in the pond" concept to identify products/tools which can compliment the Tsunami Travel Time (TTT) maps for identifying areas at risk following a tsunamigenic earthquake (WG3);

(vi) Continuing to develop and promote educational material (e.g. TsunamiTeacher) appropriate for the general public, emergency managers, policy makers, and the media (ITIC, National Contacts);

(vii) Ensuring there is a PTWS post-event evaluation whenever a Tsunami Warning or Watch is issued by PTWC or one of the Regional Warning Centres, and make this evaluation available to all parties via an IOC/PTWC website. Post-event evaluations are an essential component of continuous improvement (WG1, WG2, WG5);

Instructs the Group to submit to the Twenty-second Session of the ICG/PTWS, a draft of the medium term strategy for the Pacific Tsunami Warning and Mitigation System.

Financial implications: none

RECOMMENDATION PTWS-XXI.2

ESTABLISHMENT OF ICG/PTWS INTER-SESSIONAL WORKING GROUPS

The Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System,

Noting the devastating impact of the Indian Ocean tsunami of 26 December 2004 that highlighted the benefits of effective and durable tsunami warning systems,

Recognizing the desirability of continuously reviewing the effective and durable operation of the PTWS,

Decides to continue the five inter-sessional working groups established by ICG/ITSU-XX (Recommendation ICG/ITSU XX. 1) with terms of reference as defined in the Annex to this Recommendation:

1. Working Group One on Seismic Measurements, Data Collection and Exchange.

2. Working Group Two on Sea level Measurements, Data Collection and Exchange.

3. Working Group Three on Tsunami Hazard Identification and Characterization, including Modelling, Prediction and Scenario Development.

4. Working Group Four on Resilience Building and Emergency Management.

5. Working Group Five on Interoperability of Regional, Sub-regional and National Tsunami Warning Systems in the Pacific.

Decides further that membership of the working groups shall be open to all IOC Member States and invited organizations, and shall be convened by Chairs nominated by the ICG/PTWS,

Instructs the inter-sessional working groups to liaise, as appropriate, with similar inter-sessional working groups established by the ICG/IOTWS and other regional tsunami warning and mitigation systems, and invite Chairs of equivalent working groups in other regions to meet to ensure maximum interoperability,

Instructs the inter-sessional working groups to develop and continue to update medium term plans, a period of 5-10 years, to be reported to the Medium Term Strategy Working Group on an annual basis and to report and provide recommendations for further action to the next Session of the ICG/PTWS.

Annex to
RECOMMENDATION PTWS-XXI.2

TERMS OF REFERENCE FOR THE ICG/PTWS INTER-SESSIONAL WORKING GROUPS

Working Group One on Seismic Measurements, Data Collection and Exchange

Objectives:

- Review and report on existing arrangements with regard to seismic measurements, data collection and exchange.
- Advise on how best to ensure that all earthquakes of magnitude 6 or greater can be reliably located and sized in a timely manner.
- Review and make recommendations regarding upgrades and enhancements to the PTWS network, communications, processing and analysis to further reduce the time required for earthquake source characterization to meet desired warning responses.

Chair: USA

Working Group Two on Sea level Measurements, Data Collection and Exchange

Objectives:

- Review and report on existing arrangements with regard to sea level data collection and exchange.
- Review and monitor status of Pacific Ocean sea level networks related to tsunami observation.
- Coordinate plans for sea level observing sensitivity tests to understand the optimal, effective PTWS sea level network and associated technologies.
- Liaise with WMO CBS, JCOMM and relevant Expert Teams to develop a more effective data representation and code form for the exchange of sea level data (standards, metadata requirements).
- Review and report on various means of transmitting sea level data to warning centres, and conduct tests of latency (timeliness) of GTS transmissions.
- Liaise with other sea level measurement, data collection and exchange working groups from the other ocean basins, as well as other working groups within ICG/PTWS to coordinate and ensure efficient and effective sea level observations for tsunami warning and mitigation.

Chair: Australia

Working Group Three on Tsunami Hazard Identification and Characterization

Objectives:

- Review and report on existing arrangements with regard to tsunami hazard identification and characterization.
- Advise on credible seismic scenarios that need to be captured for numerical tsunami modelling, e.g., location, magnitude, rupture, orientation, dip, and probability of occurrence.
- Review details on models that are currently used or in development.
- Review desirable documentation (inputs, outputs etc.).
- Explore cooperation regarding coastal inundation models.
- Review as appropriate requirements for bathymetry.
- Develop guidance on mandatory metadata including detail of bathymetry, hydrography and topography.
- Consider the issue of assessing hazard, vulnerability and risk, including the facilitation of access to models.

Chair: France

Working Group Four on Resilience Building and Emergency Management

Objectives:

- Promote good practice examples of capacity and resilience building and emergency management to improve the management of tsunami risk through mitigation, preparedness, response and recovery activities. Such measures include the following:
  - risk reduction: land use planning, building standards, engineering and non-structural counter-measures, and hazard and risk assessments,
  - preparedness: capacity assessments, public education, training, response and evacuation planning and exercising,
  - response: effective forecasting and early warning systems coupled with sound communications systems,
  - recovery: infrastructure and socio-economic recovery plans supported by adequate financial and logistical resources,
  - public awareness.

Chair: Canada

Working Group Five on Interoperability of Regional, Sub-regional and National Tsunami Warning Systems in the Pacific

Objectives:

- Coordinate the development and operational implementation of warning systems in the Pacific through:
  - advice on the modalities of operation, methods and standards for the development and issuance of warnings, and requirements in terms of coordination and operating within a multi-hazard approach,
  - advice on arrangements for redundancy and back-up arrangements,
  - support the update of the PTWS Communications Plan.

Chair: USA

RECOMMENDATION PTWS XXI.3

PROGRAMME OF WORK AND BUDGET FOR 2006–2007

The Intergovernmental Co-ordination Group for the Pacific Tsunami Warning and Mitigation System;

Recalling that ICG/PTWS has been identified by the IOC Governing Bodies as a high priority and flagship programme of the Commission, being until recently the only programme within the IOC fully dedicated to the co-ordination of an operational natural hazard warming system with the goal of reducing the tsunami danger and its impact on coastal communities;

Appreciating highly the support of the Republic of Korea, France and Canada provided to the IOC Tsunami Programme in 2006 through Trust Fund contributions;

Also appreciating the continuing support of the USA in funding the operation of PTWC and WC/ATWC, and the support of Japan for the NWPTAC including the South China Sea service, as well as the support of the USA and Chile in funding the operation of ITIC;

Appreciating further the intention of Australia, Canada, Chile, Ecuador and France to provide extra-budgetary support during the 2006-2007 biennium;

Taking into account discussions, which took place during the Twentieth Session of the ICG/ITSU, and revised at ICG/PTWS-XXI regarding the programme activities and agreed upon priorities for 2006-2007;

Being informed of the IOC Programme and Budget for 2006-2007 adopted by the 23rd Session of the IOC Assembly held in Paris in June 2005 and since revised;

Recognizing further that the IOC PTWS programme cannot successfully meet its obligations without an adequate provision of resources, and that since the Indian Ocean tsunami of 26 December 2004 those obligations and commitments have increased significantly**;**

Invites all Member States to support the PTWS programme by following the example of a few Member States contributing directly to the IOC Trust Fund and earmarked for the PTWS, or in-kind by covering operational costs of maintaining the Tsunami Warning and Mitigation System;

Requests PTWS National Contacts to be pro-active in making national authorities aware of the programme and of the benefits of disaster reduction, through risk determination and resource allocation to diminish its impact;

Requests the Executive Secretary IOC to take all necessary measures for providing support to the Pacific Tsunami Warning and Mitigation System programme, by allocating the necessary funds and staff, within existing IOC resources;

Expresses a strong hope that in light of the importance and priority of the programme, and the need to provide guidance and expertise in support of recently established warning systems (e.g., the IOTWS, NEAMTWS, CARIBE-EWS), all activities mentioned in the Work Programme for 2006-2007 above, will receive the necessary funding;

Adopts the ICG/PTWS Programme and the required resources for 2006-2007 identified in Annex A;

Requests the IOC Secretariat to provide an account of the IOC funds and extra budgetary contributions allocated to the ICG/PTWS (ICG/ITSU) for the past 5 years.

Annex to
RECOMMENDATION PTWS-XXI.3

1. Participation of PTWS Officers/Experts/Secretariat in IOC meetings, meetings of other Intergovernmental Coordination Groups for regional Tsunami Warning and Mitigation Systems, and other organizations dealing with issues relevant to the Tsunami Programme.
2. Assistance to the International Tsunami Information Centre (ITIC) for its continuing activities in fulfilling its obligations to the ICG/PTWS during 2006–2007 and including the ITIC Director's travel.
3. Planning, conduct and assessment of a Pacific-wide Tsunami Warning exercise in early 2006.
4. Organization of ICG/PTWS-XXI in April 2006 (Melbourne, Australia).
5. PTWS Officers Meeting in January 2007 (Honolulu, USA).
6. Organization of ICG/PTWS-XXII in October 2007 (Ecuador).
7. Support for ICG/PTWS participation in the ICG/IOTWS and CARIBE-EWS inter-sessional Working Groups.
8. Support to the ITIC Associate Director, including one trip each year to ITIC for briefing and reporting on the accomplishments.
9. Completion and assessment of the Assessment Questionnaire for ICG/PTWS Member States.

10. Completion of the Integrated Tsunami Data Base (ITDB).
11. Support for development of the TsunamiTeacher – translations into French and Spanish.
12. Support for the Working Group on the Central American Pacific Coast Tsunami Warning System.

Budget Summary (in US$)

Priority	2006				2007			
	Funded UNESCO/ RP	Unfunded	EB Support Anticipated	EB funding source	Funded UNESCO/ RP	Unfunded	EB Support Anticipated	EB funding source
1	15,000				15,000			
2	7,000	18,000	600,000	USA	7,000	21,000	600,000	USA
3								
4	7,000	7,000	40,000	Australia				
5						16,000		
6					7000	10,000	30,000	Ecuador
7		12,000				12,000		
8			3,000	Chile			3,000	Chile
9		5,000						
10		3,000						
11			7,000	France			7,000	Chile
12		3,000				3,000		
TOTAL	29,000	48,000	650,000		29,000	62,000	640,000	

TOTALS:	**Funded**	**58,000**
	Unfunded	**110,000**
	EB Support	**1,290,000**

Funded amount is $17K (2006), $19.2K (2007) and $21.8K ($25K Canadian provided by Canada to trust) = $58K

RECOMMENDATION PTWS-XXI.4

WORKING GROUP ON THE CENTRAL AMERICA PACIFIC COAST TSUNAMI WARNING SYSTEM

The Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System,

Recognizing that Central America has a significant threat from both local and distant tsunamis;

Noting that the six countries of Central America and the Coordination Center for the Prevention of Natural Disasters in Central America (CEPREDENAC) during a meeting held in Managua, Nicaragua on 3 September 2003 decided to start the process for a Regional Tsunami Warning System, and to request IOC/ITSU assistance in developing it;

Remembering that this Intergovernmental Coordination Group in its session XIX decided to assist the Central American countries in this process and established a Working Group on their behalf composed of representatives from Nicaragua, Chile, France, observer from El Salvador, the Directors of ITIC and PTWC and chaired by the representative from Nicaragua;

Recognizing that a strategy for the Regional Tsunami Warning System was adopted by the Central American countries in a meeting April 25-27, in Managua, with the objective to create National Warning Systems in each of the countries, which shall cooperate closely and shall form finally a Regional Warning System;

Recognizing that a strategy for the Regional Tsunami Warning System was adopted by the Central American countries in a meeting from April 25–27, in Managua, with the objective to create National Warning Systems in each of the countries, which shall cooperate closely, and shall form finally a Regional Warning System,

Recognizing that Nicaragua and El Salvador already initiated to operate National Tsunami Warning Systems,

Acknowledging that they have made further improvements in Central America regarding the capabilities applicable to the requirements of a regional tsunami warning system as on line seismic data exchange and training of personnel,

Further acknowledging that there are mutual benefits to the Central America region and the Pacific region that would be realized through the establishment of this warning system,

Decides to continue with the work of the Inter-sessional Working Group on the Central America Tsunami Warning System with the following terms of reference:

1. To assist the Central American countries in the improvement, development or implementation of their National Tsunami Warning and Mitigation Systems,

2. To recommend to the Executive Secretary of CEPREDENAC the implementation of a Steering Committee for the Regional Tsunami Warning System and Mitigation Systems,

3. To facilitate Tsunami Hazard and Risk studies in the Central American Region,

4. To assist the countries which are not yet members of PTWS in their attempts to integrate IOC/PTWS,

Recommends that the Group will be composed of representatives from Nicaragua, El Salvador, Guatemala, Costa Rica, Chile, France, the Directors of ITIC and PTWC and Chaired by the representative from Nicaragua;

Acknowledges that ICG/PTWS is the Coordinating Body for the Tsunami Warning and Mitigation System in the Pacific and **encourages** non-PTWS Member States to contact the IOC Secretariat to request membership in the ICG/PTWS.

Financial implications: US$ 2,000

RECOMMENDATION PTWS-XXI.5

WORKING GROUP ON TSUNAMI WARNING AND MITIGATION IN THE SOUTHWEST PACIFIC OCEAN

The Intergovernmental Coordination Group for the Tsunami Warning and Mitigation System in the Pacific,

Recognizing that the Southwest Pacific Ocean has a significant threat from local, regional and distant tsunamis;

Further recognizing that local and regional tsunami alerts for some areas of the Southwest Pacific are not covered by the PTWC;

Further recognizing the strategic recommendations for addressing tsunami risks in the region agreed to at the South Pacific Tsunami Awareness Workshop, Suva, Fiji, 1-3 July 2004;
Noting the interest of Member States in the Southwest Pacific region to enhance their tsunami warning and mitigation services;

Acknowledging that a number of countries in the region are developing National Tsunami Warning Systems with already existing and planned upgrades to seismic and sea level networks and that the PTWC provides distant tsunami warnings for the Southwest Pacific;

Further acknowledging that there may be mutual benefits to these regions and to the Pacific Tsunami Warning and Mitigation System from the establishment of this working group;

Further acknowledging donor support, but encouraging continued effort in donor harmonization;

Decides to establish an inter-sessional Working Group on the Southwest Pacific Ocean with the following Terms of Reference:

1. to evaluate capabilities of countries in these regions for providing end-to-end tsunami warning and mitigation services;

2. to ascertain the requirements of countries in the Southwest Pacific Ocean for tsunami warning and mitigation services;

3. to facilitate tsunami hazard and risk studies in the region;

4. to facilitate cooperation in the establishment and upgrading of seismic and sea level stations and networks in the region, and the interoperability of these systems;

5. to facilitate capacity building and the sharing of tsunami information in the region, including the free and open exchange of data;

6. to support the development of the centre of expertise in a multi-hazards context within SOPAC in line with the SOPAC strategies for enhancing early warning in the region.

Recommends that the Group be composed of representatives from members countries of SOPAC as members and observers, and including France, the Directors of ITIC and PTWC and Chaired by the Representative of New Zealand, with Vice-Chairs from Fiji and Samoa;

Acknowledges that PTWS is the Coordination Body for the Pacific Tsunami Warning and Mitigation System (PTWS) and **encourages** non-PTWS Member States to contact the IOC Secretariat to request membership in the ICG/PTWS

ANNEX III

SPEECHES

A. Welcome Speech by Chair, ICG/PTWS

It is a great pleasure and honour to open the Twenty-First Session of the Intergovernmental Co-ordination Group for the Pacific Tsunami Warning and Mitigation System, as Chairman of this Group.

On behalf of the Member States of the Intergovernmental Co-ordination Group I would like to express our appreciation and thanks to the Government of Australia for hosting this Session. In its forty-one years of existence, this is the first time that the Group has met in Australia. As of today, we have had eleven meetings in the west side of the Pacific Ocean and ten in the east side of the Pacific Ocean; twelve meetings in the Northern Hemisphere and nine in the Southern Hemisphere. We expect and hope to continue with the tradition of having meetings in alternate sides of the Pacific Ocean, every two years.

Of the twenty-eight Member States of the Pacific Tsunami Warning and Mitigation System, sixteen are attending this session: Australia, Canada, Chile, China, Fiji, France, Indonesia, Japan, Republic of Korea, Malaysia, New Zealand, Nicaragua, Russian Federation, Samoa, Thailand and USA. Other organizations, including the South Pacific Applied GeoScience Commission (SOPAC) are also attending the session. I thank all the distinguished delegates for coming and for their effort to participate and contribute to the development of our Warning System.

This is the first session of the "**new**" Intergovernmental Co-ordination Group for the Pacific Tsunami Warning and Mitigation System (ICG/PTWS), formerly known as the International Co-ordination Group for the Tsunami Warning System in the Pacific (ICG/ITSU). Its name and terms of reference were officially changed last October, at ITSU-XX. The establishment by IOC, in 2005, of three other Intergovernmental Co-ordination Groups for Tsunamis in the Indian Ocean, Caribbean and North-East Atlantic and Mediterranean motivated the member States of ITSU to review its terms of reference and to change the name of the group to align them with the approaches adopted by the other groups.

The Pacific Tsunami Warning and Mitigation System covers the Pacific Ocean, the Southern Ocean regions of the Pacific and all attached seas, including the Philippine Sea, East China Sea, Yellow Sea, Sea of Okhotsk, Bering Sea, South China Sea, Java Sea, Arafura Sea, Sulawesi Sea, Sulu Sea, Celebes Sea, Bismark Sea, Solomon Sea, Coral Sea, and Tasman Sea. PTWS is an effective and coordinated network of regional, sub-regional and national systems and capacities.

Until 2005, ICG/ITSU was the only UN structure with substantial expertise on tsunami warning systems. IOC´s Member States in the Pacific Ocean have accumulated knowledge and expertise in natural disaster management and mitigation to reduce the impact of tsunamis. In particular, the existences of the Pacific Tsunami Warning Center (PTWC) and of the International Tsunami Information Centre (ITIC) have help to assess the tsunami risk at the national and local level, to promote awareness and preparedness and to build national and regional warning systems.

The Pacific Tsunami Warning Center acts as the primary operational centre for PTWS, issuing information bulletins, watches and warnings to the Pacific Region and for the time being, to other adjacent regions. ITIC keeps the Communication Plan updated, publishes the PTWS newsletter, develops and updates our website and coordinates trainings, workshops and expert missions to Member States.

The Intergovernmental Co-ordination Group, **US**, has the mandate to coordinate the activities of PTWS, to organize and facilitate the exchange of seismic, sea level and other data at or near real-time and information required for the interoperability of the PTWS, to promote the sharing of experience and expertise related to tsunami warning and mitigation, to promote the establishment and further development of national tsunami warning and mitigation capacities, to promote capacity building, among other functions.

During this week, we will review the work and progress accomplished during the last six months. Our attention will be focus on the reports of the five inter-sessional Working Groups established at ITSU-XX and on the Pacific-wide Tsunami exercise planned for May 16 and 17.

Finally, I would like to thank the Local Organizing Committee, especially Peter Dexter and Carl Muller, for their hard work during the past six months to organize this session.

I wish you a very successful and productive Session.

B. Welcome Speech
by Director of the Australian Bureau of Meteorology, Dr Geoff Love

Summary of Welcome Speech

There is a lot of interest in tsunami warning systems because of the 2004 Indian Ocean tsunami, and this has presented us with the opportunity to work together to build an effective tsunami warning system. Tsunami warning systems (TWS) involve contributions from a lot of disciplines which don't usually work together, like meteorologists, seismologists, communications experts and disaster managers. We have the opportunity to build this community and we have the support of governments. Another opportunity exists to increase our capacity for data exchange. We have to create a new philosophy in data exchange, which is important because we can't keep data to ourselves. The expense of gathering data is a big investment and we have the opportunity to develop a data exchange paradigm the world needs. If we work together as a community we have the opportunity to save lives. We have to build a system that has a memory that goes on after we have retired from our jobs, and we have to build something which is enduring.

We have to build the end-to-end system and these meetings will help. Each of us has a role to play and meetings like this help to accomplish this.

Welcome to Melbourne.

C. Welcome Speech
by Dr Patricio Bernal, Executive Secretary IOC.

Dear Colleagues:

This is the second time that the PTWS is meeting in less than a year, now here in Melbourne and under its new format, as the Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System (ICG/PTWS). After the benchmarking meeting in Valparaiso, new activities have been enthusiastically and courageously undertaken by the Group.

We are only few days away from "Pacific Wave 06", the first end-to-end Pacific-wide tsunami exercise scheduled for the 16 and 17 of May.

"Pacific Wave 06", reflecting the architecture of the system, will focus on the two components of the system: the evaluation and issuance of warning messages by the designated warning centres to the national tsunami focal points, and the national and/or local response and warning dissemination and communication mechanisms once a warning is received. We are relying on international cooperation in building the detection networks and developing advice; we must rely on national governments for issuing the warning to the people and coordinating responses and developing effective national mitigation strategies.

National governments take full responsibility of issuing the warnings in their territories, and ensure the downstream flow of information from the focal point centre to the peripheral concerned parties; from the central government to the provincial, regional and community level. National governments are also responsible for putting in place and implementing the necessary awareness and emergency-preparedness plans.

The exercise is capturing the attention of the world-press as they anticipate and assess the readiness of the countries around the Pacific to react to the announcement of the arrival of a destructive Pacific-wide tsunami

upon their shores. To give you an idea of the degree on interest, the IOC have received inquiries in the Secretariat asking where European TV crews should go to better witness the exercise.

It should not be a surprise if we get our best marks in the flow of advice and information to, and in the response from, the national tsunami centres and focal points; we regularly exercise this part of the system through communication drills. From there onward, the system becomes much more complex and diffuse and we know that the strength, speed and reliability of the links and the clarity of the procedures to apply, differs markedly from place to place. We will be waiting with great interest the report on the exercise that will be made by the Chair of the ICG/PTWS to the Executive Council in late June 2006.

Major plans are also underway to improve the detection networks in the Pacific and especially in its regional seas.

As I recalled last year in my address to the Valparaiso meeting, IOC reacted very fast to the December 2004 tragedy off the coast of Sumatra, by coordinating and assisting in the establishment of an effective initial warning and mitigation system for tsunami risks in the Indian Ocean. This work is progressing well, and we are completing its first phase. The interim tsunami warning system to be inaugurated in July will be composed of an improved seismographic network (25 new stations, compared with the 9 that were operating in December 2004) and a completely new real-time sea level network (23 stations of which 17 are operating today), plus three DART buoys, one deployed by Malaysia and two by Germany, out of the planned 60.
From July 2006, this initial system will be capable of:

- Improved and faster detection of strong, tsunamigenic earthquakes
- Increased precision in the location of epi- and hypocentres of earthquakes, enabling the accurate application of tsunami warning protocols.
- Confirming the presence of a tsunami wave in the ocean after a strong earthquake
- Issuing a “tsunami watch”, “regional tsunami watch” or a “ocean-wide tsunami ocean warning”
- Cancel “tsunami watches” and “regional tsunami watches”

These are all ‘firsts’ for the Indian Ocean.

But since tsunami risks exist in all ocean basins to a different degree, UNESCO through its IOC proposed a Global strategy to establish early warning systems not only in the Indian Ocean but also in the Caribbean, the Mediterranean and North-East Atlantic. During the last year, we have made progress in all those areas. In November we had the first meeting of the North East Atlantic and Mediterranean ICG in Rome. The meeting agreed in principle to have an initial system operating for the end of 2007. The Second Session of the ICG for the NE Atlantic and Mediterranean Tsunami Warning and Mitigation System will take place in Nice, France, 22 - 24 May 2006. This session is being hosted by the Government of France with support from le Conseil Général des Alpes Maritimes.

From the 10 to the 12 of January of this year, the Caribbean countries met in Barbados to take stock of the significant infrastructure and institutional arrangements already active in the Region and immediately jump-started their work. National plans and a series of immediate actions had already taken place during 2005 to improve the protection of coastal regions from tsunami hazard in the western Atlantic and Caribbean basin. In the USA, as part of a national preparedness plan, all Counties in Florida had reached the status of “tsunami ready” communities. In April 2005, the US Geological Survey, USGS, with other international partners completed a shipboard survey of tsunami and earthquake hazard in the Northern Caribbean and is helping to calibrate the Puerto Rico seismographic network.

The Alaska and Hawaii Tsunami Warning Centers of NOAA that are part of the IOC’s International Tsunami Warning System in the Pacific, have already expanded their services to provide tsunami alert information to the US Atlantic Coast, Gulf of Mexico, Puerto Rico, the US Virgin Islands and Eastern Canada. By April 2006 US-NOAA will have three new sea level stations operational in the Caribbean and the USGS will deploy nine new seismic stations in the Caribbean as part of the Global Seismographic Network, stations that will provide data to NOAA’s Tsunami Warning Centers in the Pacific. A few days ago the first DART buoys were deployed by the USA through NOAA in the Caribbean region.

Dear Colleagues:

We should not forget that within ITSU it has been suggested for many years to create Warning Systems in the Indian Ocean, and in the Caribbean but we were unsuccessful to reach and convince the governments that this was necessary. We still have a unique opportunity to do so, but this represents a huge challenge.

IOC has started three new Intergovernmental Coordination Groups: for the Indian Ocean, the NE Atlantic and Mediterranean, and the Caribbean. The Pacific has intensified its work doubling the frequency of its meetings. We are today implementing projects in several countries, addressing different aspects of tsunami work.

We have now a basic framework to move ahead at the global level. The ICG of the Indian Ocean TWS is being supported from Perth by a Secretariat composed of two new professionals. At headquarters, we are finalizing the formation of a Tsunami Unit, providing technical support to the Secretariats in Perth and Hawaii, and the rest of the world, with a newly hired Head of unit and four professionals. All this is very good, however, the only new resources that IOC has received to finance these new activities are earmarked for the Indian Ocean and we cannot spend them elsewhere. As an example, we have asked our Pacific-based ITIC to take a strong role globally to share the experience and know-how of tsunami warning and mitigation, but have not been able to increase her Staff accordingly. So, things as they are today are unsustainable without further resources for other oceans.

We must look carefully on our current strategies to communicate and achieve governmental engagement and investment in our global programmes, both for technical capacity and for coordination.

In my view, the IOC Assembly anticipated part of these difficulties when addressing this global imperative established, through Resolution XXIII-15, an *"ad hoc Working Group to prepare a framework for a global tsunami and other ocean-related hazards early warning system"*, inviting WMO, ISDR, GEO and other relevant intergovernmental and international organizations to actively take part in this process.

There are two different questions here. On one side, we need to ensure that the investments in tsunami detection networks under IOC, essential for the "upstream flow" of data necessary to issue a "tsunami watch" or warning, are accompanied by a parallel long-term investment securing the "downstream flow" of the information from the centres of warning to the people at risk. That is we need to improve national engagement to secure the "last mile", getting the warning to the people at risk, and to have the plans at hand so everybody knows what to do in the case of an emergency. Here ISDR, WMO and others can make their contribution.

But on the other side we also need to sustain the increased level of activities and coordination necessary to extend and maintain that global tsunami coverage. Furthermore, if we want to integrate the regional systems more, to use the synergies and make them truly multi-hazard, we also need more international coordination, and to support it accordingly.

Finally in the IOC we need to look back on our original point of departure, and start conceiving the Tsunami warning as integrated into, and a part of the broader and multipurpose ocean observing system. As such, it should optimize the effectiveness and make more efficient the investment of resources needed for maintaining it.

Dear Colleagues:
At the beginning I used the words enthusiastic and courageous. We have the enthusiasm to undertake these tasks because we are convinced that the science and technology that we have today can and should protect the life and property of all the peoples around the oceans of the world. Courageous, because we have taken in our hands huge responsibilities, that we know requires full cooperation and trust of others, and we are doing it in a totally transparent and accountable way. This grouping of professionals embodies at the same time a community of knowledge and a community of practice, of practitioners. That is what is required to build a System, a System that is reliable, effective and responsive to needs. Because of that, I do not think we have another responsible alternative, but to lead with courage and enthusiasm, and I thank this group for its willingness to do just that.

Thank you very much.

D. Speech by the Honourable Greg Hunt, Australia Secretariat to the Minister for Environment and Heritage

The 2004 Indian Ocean Tsunami was a wake up call to people around the globe. The magnitude of the disaster is difficult to comprehend. There are many challenges associated with setting up an effective warning system. Australia has developed emergency management responses for cyclones and bushfires, and we have very efficient early warning models for these hazards. It is a challenge to get the message out to the community during an event. We need to exchange ideas with other countries and share our experiences. Although we have extensive experiences with cyclones and bushfires, but we now have to extend this to other hazards like tsunamis. Australia has allocated $69 million dollars to develop our tsunami warning and mitigation system. We have allocated $10 million dollars to our Pacific program, to help Pacific Island nations face these hazards. We are working with many partners including the Pacific Tsunami Warning System, but there are clear gaps, especially in the South Pacific. There is a sense of urgency to improve the system in this area, especially as our goal is to ensure that every island nation in the SW Pacific is included in the Pacific Tsunami Warning System. We will help with the technology, the training, and other needs. I urge nations which are not yet members of the PTWS to join, and we will offer all the support you need. I want to thank the Chairman and all the members here today for their work and their contribution, and their commitment to develop something which will outlive all of us and save lives in the future. Thank you.

ANNEX IV

LIST OF DOCUMENTS

AGENDA ITEM	1. WORKING DOCUMENTS	TITLE	DATE
2.1	IOC/PTWS-XXI/1 Prov.	Provisional Agenda	May-06
2.1	IOC/PTWS-XXI/1	Agenda	May-06
2.3	IOC/PTWS-XXI/1 Add.prov.	Provisional Timetable	26-Apr-06
2.1	IOC/PTWS-XXI/2	Annotated Provisional Agenda	2-May-06
	IOC/PTWS-XXI/3	Summary Report	1-May-07
	IOC/PTWS-XXI/3s	Executive Summary	13-Jun-06
	IOC/PTWS-XXI/3s	Executive Summary	13-Jun-06
2.3	IOC/PTWS-XXI/4 prov.	Provisional List of Documents	May-06
	IOC/PTWS-XXI/4	List of Documents (this document)	May-07
2.3	IOC/PTWS-XXI/5 prov.	Provisional List of Participants	May-06
	IOC/PTWS-XXI/5	List of Participants	May-07
3.1	IOC/PTWS-XXI/6	Report of the ICG/PTWS Chairman	May-06
3.2	IOC/PTWS-XXI/7	National Reports	
	IOC/PTWS-XXI/7.1	Chile	May-06
	IOC/PTWS-XXI/7.2	Japan	May-06
	IOC/PTWS-XXI/7.3	Russian Federation	May-06
	IOC/PTWS-XXI/7.4	Peru	May-06
	IOC/PTWS-XXI/7.5	Malaysia	May-06
	IOC/PTWS-XXI/7.6	Nicaragua	May-06
	IOC/PTWS-XXI/7.7	El Salvador	May-06
	IOC/PTWS-XXI/7.8	Canada	May-06
	IOC/PTWS-XXI/7.9	France	May-06
	IOC/PTWS-XXI/7.10	Costa Rica	May-06
	IOC/PTWS-XXI/7.11	Ecuador	May-06
	IOC/PTWS-XXI/7.12	Thailand	May-06
	IOC/PTWS-XXI/7.13	New Zealand	May-06
	IOC/PTWS-XXI/7.14	Samoa	May-06
	IOC/PTWS-XXI/7.15	China	May-06
	IOC/PTWS-XXI/7.16	Australia	May-06
	IOC/PTWS-XXI/7.17	USA	May-06
	IOC/PTWS-XXI/7.18	Tonga	May-06
	IOC/PTWS-XXI/7.19	Republic of Korea	May-06
	IOC/PTWS-XXI/7.20	Fiji	May-06
	IOC/PTWS-XXI/7.21	Colombia	May-06
	IOC/PTWS-XXI/7.22	Singapore	May-06
3.3	IOC/PTWS-XXI/8	Report of the ITIC Director	May-06
3.4	IOC/PTWS-XXI/9	Report of the PTWC Director	May-06
3.5	IOC/PTWS-XXI/10	Report of the JMA Director	May-06
1	IOC/PTWS-XXI/11	Welcome Speeches	
	IOC/PTWS-XXI/11.1	1. UNESCO-IOC Assistant Director General	3-May-07
	IOC/PTWS-XXI/11.2	2. ICG/PTWS Chair	3-May-07
5.2	IOC/PTWS-XXI/12	Communications Plan for the Pacific Tsunami Warning System	May-06
4.1	IOC/PTWS-XXI/12	NWPTAC Handbook (Communications Plan for the PTWS)	May-06
4.1	IOC/PTWS-XXI/13	NWPTAC Communications Test Results	May-06
3.8	IOC/PTWS-XXI-14	Exercise Pacific Wave Manual	4-May-06

AGENDA ITEM	1. WORKING DOCUMENTS	TITLE	DATE
3.9	IOC/PTWS-XXI-15	03 May 2006 Tonga Earthquake	3-May-07
		1. Overview	3-May-07
		2. PTWC Messages	3-May-07
3.11.4	IOC/PTWS-XXI-16	Sea Level Data and Station Metadata Project	May-07
3.12.1	IOC/PTWS-XXI/17	Report on Integrated Tsunami Database (ITDB)	May-06
3.12.3	IOC/PTWS-XXI/18	Tsunami Reconnaissance Digital Data Repository	May-07
4.3.2	IOC/PTWS-XXI/19	SOPAC Activity Report	3-May-07
AGENDA ITEM	**2. INFORMATION DOCUMENTS**	**TITLE**	**DATE**
	IOC/PTWS-XXI/Inf.1	Information for Visitors for PTWS-XXI	Apr-06
		Application for a Sponsored Business Visitor (short stay) Visa (1238)	
		Central Melbourne Map	
	IOC/PTWS-XXI/Inf. 2	List of PTWS National Contacts	ongoing
	IOC/ITSU-XX/3	Summary Report, ICG/ITSU-XX	3-Nov-05
	IOC/ITSU-XX/3s	Summary Report, ICG/ITSU-XX, Abstracts, Resolutions and Recommendations	3-Nov-05
	IOC/PTWS-XXI/Inf. 3	Summary of Action Items, ICG/ITSU-XX	May-06
	IOC/XXIII/3	Resolutions adopted, 23rd Session of the IOC Assembly	Jun-05
3.11.4	IOC/INF-1226	Meeting on the Development of a Sea Level Metadata Web Service Demonstrator Project [March 2006]	Mar-06
3.11.4	IOC/INF-1227	Meeting on the Development of an ODINAFRICA Sea Level Data Facility	Mar-06
5.3	IOC/INF-1124	ITSU Master Plan	1999
6.2	IOC/PTWS-XXI/Inf. 5	QUESTIONNAIRE: Assessment of Requirements and Capacity for an Effective and Durable National Tsunami Warning and Mitigation System	Mar-06
7.2	IOC/Manuals and Guides, 47	IOC TsunamiTeacher	Sep-06
		TsunamiTeacher Information Document	
		TsunamiTeacher - Users Guide	
9.5	WMO-No. 995	JCOMM-II Abridged final report with resolutions and recommendations: Relationship with Other Programmes/Bodies of WMO and IOC - Natural Disaster Reduction - Item 11.5	Sep-05
AGENDA ITEM	**3. OTHER DOCUMENTS**	**TITLE**	**DATE**
	CL 2188	Letter of Invitation to PTWS-XXI	17-Mar-06
4.1	CL 2187	Inauguration of Northwest Pacific Tsunami Advisory Center (NWPTAC) Start of Interim Tsunami Advisory Service for the South China Sea	10-Mar-06
3.2	IOC/INF-1202	National Report Format	Apr-06
5.2	IOC/PTWS-XXI/13	7x24 Tsunami Focal Point Form (Communications Plan for the PTWS)	Jun-06
	IOC/INF-1221	ICG Terms of Reference (from Tsunami Glossary)	Apr-06
	IOC/PTWS-XXI/Inf. 4	List of IOC Circular Letters Related to PTWS	
		Users Guide for the Interim Tsunami Advisory Information Service for the Indian Ocean Region (formerly Communications Plan)	28-Feb-07
AGENDA ITEM	**4. SUMMARY DOCUMENTS**	**TITLE**	**DATE**
	IOC/EC-XXXIX/3	Summary Report, IOC Executive Council - PTWS	Jun-06
	IOC/PTWS-XXI/3	Summary Report, ICG/PTWS-XXI	May-07

AGENDA ITEM	1. WORKING DOCUMENTS	TITLE	DATE
	IOC/PTWS-XXI/3s	Executive Summary, ICG/PTWS-XXI	13-Jun-07
AGENDA ITEM	**5. EXERCISE PACIFIC WAVE 06**	**TITLE**	**DATE**
3.8	IOC/ITSU-XX.3	Recommendation, Pacific-wide Tsunami Exercise	Sep-05
3.8	CL 2186	ICG/PTWS Pacific-wide Tsunami Exercise "Exercise Pacific Wave 06"	6-Mar-06
3.8	IOC/PTWS-XXI-14	Exercise Pacific Wave Manual	4-May-06
		Exercise Pacific Wave '06 Preliminary Report	13-Jun-06
	IOC/INF-1244	Exercise Pacific Wave '06 Final Report	May-07

ANNEX V

LIST OF PARTICIPANTS

I. MEMBER STATES

AUSTRALIA

Dr Ray P. CANTERFORD
Branch Head
Weather and Ocean Services Policy
Services and Systems Division
Australian Bureau of Meteorology
PO Box 1289
Melbourne VIC 3001
AUSTRALIA
Tel: <61> (3) 9669 4087
Fax: <61> (3) 9669 4695
E-mail: r.canterford@bom.gov.au

Mr Rick BAILEY
Project Director
Australian Tsunami Warning System
Australian Bureau of Meteorology
PO Box 1289
Melbourne VIC 3001
AUSTRALIA
Tel: <61> (3) 9669 4103
Fax: <61> (3) 9669 4695
E-mail: r.bailey@bom.gov.au

Mr Gordon CHEYNE
Project Manager
Australian Tsunami Warning System
Project
Geoscience Australia
GPO Box 378
Canberra ACT 2601
AUSTRALIA
Tel: <61> (2) 6249 9762
E-mail: gordon.cheyne@ga.gov.au

Ms. Suzanne EDGECOMBE
Director, Humanities & Emergencies
Section
Australian Agency for International
Development
GPO Box 887
Canberra ACT 2601
AUSTRALIA
Tel: <61> (2) 6206 4660
Fax: <61> (2) 6206 4587
E-mail:
suzanne.edgecombe@ausaid.gov.au

Mr Robert OWEN-JONES
Director, Environment
Department of Foreign Affairs and Trade
Level 10, Angel Place
123 Pitt Street
Sydney NSW 2000
AUSTRALIA
Tel: <61> (2) 6261 3516
E-mail: robert.owen-jones@dfat.gov.au

Mr Spiro SPILIOPOULOS
Australian Tsunami Warning System
(ATWS)
Geoscience Australia
GPO Box 378
Canberra ACT 2601
AUSTRALIA
Tel: <61> (2) 6249 9494
E-mail: spiro.spilipoulos@ga.gov.au

Mr Mark SULLIVAN
Director, Capability Development
Emergency Management Australia
UCIC
PO Box 1020
Dickson ACT 2602
AUSTRALIA
Tel: <61> (2) 6256 4693
Fax: <61> (2) 6256 4653
E-mail: mark.sullivan@ema.gov.au

CANADA

Mr Fred STEPHENSON *(Vice-Chair)*
Manager, Geomatics Engineering
Canadian Hydrographic Service
Institute of Ocean Sciences
P.O. Box 6000
Sidney, B.C. V8L 4B2
CANADA
Tel: <1> (250) 363 6350
Fax: <1> (250) 363 6323
E-mail: stephensonf@pac.dfo-mpo.gc.ca

Dr Garry ROGERS
Natural Resources Canada
Geological Survey of Canada
Pacific Geoscience Centre
9860 West Saanich Road
P.O. Box 6000
Sidney, B.C. V8L 4B2

CANADA
Tel: <1> (250) 363 6450
Fax: <1> (250) 363 6565
E-mail: garry.rogers@nrcan-rncan.gc.ca

CHILE

Dr Rodrigo. NUÑEZ ***(Chair)***
Deputy Director
Servicio Hidrográfico y Oceanográfico de la Armada (SHOA) de Chile
Errazuriz 232 Playa Ancha
Valparaíso CHILE
Tel: <56> (32) 26 65 01
Fax: <56> (32) 26 65 42
E-mail: rnunez@shoa.cl

CHINA

Dr W. T. WONG
Senior Scientific Officer
Hong Kong Observatory
134A Nathan Road
Kowloon HONG KONG
Tel: <852> 2926 8430
Fax: <852> 2302 4521
E-mail: wtwong@hko.gov.hk

Mr Fujiang YU
Researcher
National Marine Environmental Forecasting
Center (NMEFC)
8 Daihusu, Haidian District
Beijing 100081 CHINA
Tel: <86> (10) 621 73 615
Fax: <86> (10) 621 73 620
E-mail: yufj@nmefc.gov.cn

Mr Tianyu ZHANG
Researcher
NMEFC
8 Dahuisi, Haidian District
Beijing 100081 CHINA
Tel: <86> (10) 0210 5740
Fax: < 86> (10) 6217 3620
E-mail: zhangty@nmefc.gov.cn

COOK ISLANDS

Mr Arona NGARI
Director, Meteorological Service
P.O. Box 127
RAROTONGA
Tel: <682> 20603
Fax: <682> 21603
E-mail: angari@oyster.net.ck and angari@met.gov.ck

FIJI

Mr Lasarusa VUETIBAU
Senior Seismologist, Seismology Section
Mineral Resources Department (MR.D)
Mead Road
SUVA
Tel: <679> 338 1611
Fax: <679> 337 0039
E-mail: lasarusa@Mr.d.gov.fj

Mr Alipate WAQAICELUA
Manager, Forecaster Services
Fiji Meteorological Service
Private Mail Bag
NADI AIRPORT
Tel: <679> 672 4888
Fax: <679> 672 0430
E-mail: Alipate.Waqaicelua@met.gov.fj

FRANCE

Dr François SCHINDELÉ ***(Past Chair)***
Assistant Director, Département Analyse et Surveillance de l'Environnement
Laboratoire de Géophysique, B.P. 12
91680 Bruyères-le-Châtel
FRANCE
Tel: <33> (1) 69 26 50 63
Fax: <33> (1) 69 26 70 23
E-mail: francois.schindele@cea.fr

Mr Antonio Falemana ILALIO
Directeur de la sécurité civile
Haut-commissariat de la République Française en Nouvelle-Calédonie
Bâtiment Foch - BP C5
98 844 Nouméa Cedex
FRANCE
Tel: <687> 26 63 10
Fax: <687> 26 63 18
E-mail: antonio.ilalio@nouvelle-caledonie.gouv.fr

Mr Denis MUSSON
Director, French Polynesia Civil Defense
French Government High Commission
BP 115, 98713 Papeete, Tahiti
FRENCH POLYNESIA
Tel: <689> 46 85 90
Fax: <689> 46 85 99
E-mail: denis.musson@polynesie-francaise.gouv.fr

Mr Dominique REYMOND
Director
Centre Polynésien de Prévention des Tsunamis
CEA/DASE/Laboratoire de Géophysique
PO BOX 640
Papeete 98713
French Polynesia
Tel: <689> 82 80 25
Fax: <689> 83 50 37
E-mail: reymond.@labogeo.pf

Mr Benoît TREVISANI
Cabinet-Chief, High-Commissioner
French Government High Commission
BP 115, 98713 Papeete,Tahiti
FENCH POLYNESIA
Tel: <689> 46 85 20
Fax: <689> 46 85 99
E-mail: benoit.trevisani@polynesie-francaise.gouv.fr

JAPAN

Mr Osamu KAMIGAICHI
Senior Coordinator, International Earthquake and Tsunami Information
Seismological and Volcanological Department
Japan Meteorological Agency (JMA)
1-3-4 Otemachi, Chiyoda-ku
Tokyo 100-8122
JAPAN
Tel: <81> (3) 3284 1743
Fax: <81> (3) 3215 2963
E-mail: okamigai@met.kishou.go.jp

Mr Yosuke IGARASHI
Chief, International Tsunami Information Section, Earthquake and Tsunami Observations Division, Seismological and Volcanological Department
Japan Meteorological Agency
1-3-4 Ote-machi
Chiyoda-ku, Tokyo 100-8122
JAPAN
Tel: <81> (3) 3284 1743
Fax: <81> (3) 3215 2963
E-mail: yosuke.igarashi@met.kishou.go.jp

KOREA, REPUBLIC OF

Dr Jun Hee LEE
Deputy Director, Earthquake Planning Division
Korea Meteorological Administration (KMA)
460-18, Sindaebang-dong, Dongjak-gu
Seoul 156-720
REPUBLIC OF KOREA
Tel: <82> (2) 181 0763
Fax: <82> (2) 841 7664
E-mail: ljh@kma.go.kr

Dr Yong Gyu RYOO
Researcher, Marine Meteorology & Earthquake Research Laboratory
Meteorological Research Institute
460-18, Sindaebang-dong, Dongjak-gu
Seoul 156-720
REPUBLIC OF KOREA
Tel: <82> (2) 847 2495
Fax: <82> (2) 847 2496
E-mail: ryooyg@kma.go.kr

MALAYSIA

Mr Mejar Mohd Sakri Bin Haji HUSSIN
Assistant Director, Management Directorate,
Prime Minister's Department Malaysia
National Security Division
G Level, West Wing
Perdana Putra Building
Federal Government Administrative Centre
62502 W.P PUTRAJAYA
MALAYSIA
Tel: <603> 8888 2063
Fax: <603> 8888 3051
E-mail: sakri@bkn.jpm.my and sakrihussin@yahoo.com

Ms Chow Peng LEONG
Deputy Director General (Application)
Malaysian Meteorological Department
Jalan Sultan
46667 Petaling Jaya
SELANGOR
Tel: <60> (3) 796 78002
Fax: <60> (3) 795 50964
E-mail: lcp@kjc.gov.my

NEW ZEALAND

Dr Rob BELL
Science Leader-Natural Hazards
National Institute of Water & Atmospheric Research (NIWA)
P.O. Box 11-115
Hamilton 2034 NEW ZEALAND
Tel: <64> (7) 856 1742
Mobile: <64> (27) 233 2324
Fax: <64> (7) 856 0151
E-mail: r.bell@niwa.co.nz

Mr Graeme BLICK
Manager, Geodesy
Land Information New Zealand (LINZ)
160 Lambton Quay
P.O. Box 5501
Wellington NEW ZEALAND
Tel: <64> (4) 471 6859
Fax: <64> (4) 460 0112
E-mail: gblick@linz.govt.nz

Dr Geoff CLITHEROE
GeoNet Systems Development Manager
GNS SCIENCE
1 Fairway Ave.
Avalon
P.O. Box 30 368
Lower Hutt NEW ZEALAND
Tel: <64> (4) 570 4762
Fax: <64> (4) 570 4600
E-mail: g.clitheroe@gns.cri.nz

Mr David COETZEE
Emergency Management Planner
Ministry of Civil Defence & Emergency Management
P.O. Box 5010
Wellington NEW ZEALAND
Tel: <64> (4) 473 7363
Fax: <64> (4) 473 7369
E-mail: david.coetzee@dia.govt.nz

Dr Ken GLEDHILL
GeoNet Project Director
GNS SCIENCE
1 Fairway Ave
P.O Box 30368
Lower Hutt 6315 NEW ZEALAND
Tel: <64> (4) 570 4848
Fax: <64> (4) 570 4676
E-mail: k.gledhill@gns.cri.nz

Mr Glen ROWE
Data Analyst (Tidal), Hydrographic Services
Land Information New Zealand (LINZ)
160 Lambton Quay
P.O. Box 5501
Wellington NEW ZEALAND
Tel: <64> (4) 460 0569
Fax: <64> (4) 498 3837
E-mail: growe@linz.govt.nz

NICARAGUA

Dr Wilfried STRAUCH
Director, Geophysical Department
Instituto Nicaraguense de Estudios Territoriales (INETER)
Managua APDO 2110
Tel: <505> 249 2761 ext. 104
Fax: <505> 249 1082
E-mail: wilfried.strauch@gf.ineter.gob.ni

RUSSIAN FEDERATION

Ms Tatiana IVELSKAYA
Chief, Sakhalin Tsunami Warning Center
Federal Service of Russia for Hydrometeorology and Environmental Monitoring
78 Zapadnaya Str
Yuzhno-Sakhalinsk 693000
RUSSIA
Tel: <7> (4242) 423691
Fax: <7> (4242) 721307
E-mail: T_Ivelskaya@SakhugMs.ru and Tanya.Ivelskaya@gmail.com

Dr Dmitry KAMAEV
Head, Laboratory of Mathematical Methods
Federal Environmental Emergency Response Centre of Roshydromet
Scientific Production Association "Typhoon"
82 Lenin Street
Obninsk, Kaluga Region 249038
RUSSIA
Tel: <7> (48439) 449 50
Fax: <7> (48439) 407 04
E-mail: kda@feerc.obninsk.org

Dr Alexander B. RABINOVICH
P.P. Shirshov Institute of Oceanology
36 Nakhimovsky Prosp.
Moscow 117997
RUSSIA

Tel: <7> (495) 124 8713
Fax: <7> (495) 124 8713
E-mail: abr@iki.rssi.ru

Mr Lev RYZHKOV
Leading Specialist, Tsunami Warning System Supervisor
Polar & Marine Works Division, Roshydromet
Novovagan'kovski Str., 12
Moscow 123995
RUSSIA
Tel: <7> (495) 255 23 88
Fax: <7> (495) 253 94 84
E-mail: icedep@mcc.mecom.ru

SAMOA

Mr Faatali Malaefatu LEAVASA
Meteorology Division
Ministry of Natural Resources, Environment & Meteorology
Private Mail Bag
Apia SAMOA
Tel: 006 852 3701
Fax: 006 852 3176
E-mail: mleavasa@meteorology.gov.ws

Ms. Filomena NELSON
Disaster Management Department
Meteorology Division
Ministry of Natural Resources, Environment & Meteorology
Private Mail Bag
Apia SAMOA
Tel: 006 852 3701
Fax: 006 852 3176
E-mail: Filomena.nelson@mnre.gov.ws

THAILAND

Adm. Thaweesak DAENGCHAI
Assistant Executive Director
Administration
Rattanathibet Rd., Bang Kra Sor
Muang, Nontaburi
THAILAND
11000
Tel: <66> (0) 2589 2497 ext. 17
Fax: <66> (0) 2589 2497 ext. 22

Mr Kriengkrai KHOVADHANA
Deputy-Director General
Thai Meteorological Department (TMD)
4353 Sukhumvit Road, Bang-Na District
Bangkok 10260
THAILAND
Tel: <662> 398 9888
Fax: <662> 399 4016
E-mail: kriengkrai@metnet.tmd.go.th

USA

Dr David GREEN
NOAA Tsunami Program Manager
1325 East West Hwy,
Silver Spring MARYLAND 20910
USA
Tel: <1> (301) 713 3557x172
E-mail: david.green@noaa.gov

Dr Charles McCREERY *(Past Vice-Chair)*
Director, Pacific Tsunami Warning Center (PTWC)
91-270 Fort Weaver Rd.
Ewa Beach HAWAII 96706-2928
USA
Tel: <1> (808) 689 8207 x301
Fax: <1> (808) 689 4543
E-mail: mccreery@ptwc.noaa.gov
(Also representing the PTWC)

Mr David McKINNIE
Coordinator, NOAA Indian Ocean, Tsunami Warning System Project
C/o Pacific Marine Environmental Laboratory
7600 Sand Point Way NE
Seattle WASHINGTON 98115
USA
E-mail: david.mckinnie@noaa.gov

Dr Stuart WEINSTEIN
Asst. Director, Pacific Tsunami Warning Center (PTWC)
91-270 Fort Weaver Rd.
Ewa Beach HAWAII 96706-2928
USA
Tel: <1> (808) 689 8207
Fax: <1> (808) 689 4543
E-mail: stuart.weinstein@noaa.gov
(Also representing the PTWC)

Mr Brian YANAGI
International Tsunami Information Centre (ITIC)
737 Bishop St., Suite 2200
Honolulu HAWAII 96813-3213, USA
Tel: <1> (808) 532 6424
Fax: <1> (808) 532 5576
E-mail: brian.yanagi@noaa.gov
(Also representing IOC-ITIC)

II. ORGANIZATIONS

World Meteorological Organization (WMO)

Dr Ray P. CANTERFORD
Acting President of CIMO
Branch Head
Weather and Ocean Services Policy
Services and Systems Division
Australian Bureau of Meteorology
PO Box 1289
Melbourne VIC 3001
AUSTRALIA
Tel: <61> (3) 9669 4087
Fax: <61> (3) 9669 4695
E-mail: r.canterford@bom.gov.au
(Also representing Australia)

Dr Peter DEXTER
Co-President of JCOMM
Ocean Services Section
Weather and Ocean Services Policy
Branch
Bureau of Meteorology
GPO Box 1289
Melbourne VIC 3001
AUSTRALIA
Tel: <61> (3) 9669 4870
Fax: <61> (3) 9669 4695
E-mail: p.dexter@bom.gov.au

Pacific Tsunami Warning Center (PTWC)

Dr Charles McCREERY *(Past Vice-Chair)*
Director, Pacific Tsunami Warning Center (PTWC)
91-270 Fort Weaver Rd.
Ewa Beach HAWAII 96706-2928
USA
Tel: <1> (808) 689 8207 x301
Fax: <1> (808) 689 4543
E-mail: mccreery@ptwc.noaa.gov
(Also representing the USA)

Dr Stuart WEINSTEIN
Assistant Director, Pacific Tsunami Warning Center (PTWC)
91-270 Fort Weaver Rd.
Ewa Beach HAWAII 96706-2928
USA
Tel: <808> 689 8207
Fax: <808> 689 4543
E-mail: stuart.weinstein@noaa.gov
(Also representing the USA)

SOPAC

Mr Atunaisa KALOUMAIRA
Advisor, Community Risk Programme
South Pacific Applied GeoScience Commission (SOPAC)
SOPAC Secretariat
Private Mail Bag
GPO SUVA
Tel: <679> 3381 377
Fax: <679> 3370 040
E-mail: atu@sopac.org

III. OBSERVERS

AUSTRALIA

Mr Graeme BROUGH
Project Manager
Almos Systems Pty Ltd
Level 9/440 Collins Street
Melbourne VIC 3000
AUSTRALIA
Tel: <61> (03) 9670 4668 / 9607 1334
Fax: <61> (03) 9607 1332
E-mail:
Graeme.Brough@talvent.abengoa.com

Mr Geoff CRANE
Warning Systems Specialist
Australian Tsunami Warning System
Bureau of Meteorology
700 Collins Street
Docklands VIC 3008
GPO BOX 1289
Melbourne VIC 3001
AUSTRALIA
Tel: <61> (3) 9669 4110
Fax: <61> (3) 9669 4695
E-mail: g.crane@bom.gov.au

Dr Dale DOMINEY-HOWES
Senior Lecturer in Natural Hazards and Disaster Studies
Department of Physical Geography
Macquarie University NSW 2109
AUSTRALIA
Tel: <61> (2) 9850 9679
Fax: <61> (2) 9850 8420
E-mail: ddominey@eels.mq.edu.au

Mr Brian FLANAGAN
Assistant Director Tsunami Warning Implementation (Community Safety)
Attorney-General's Department
Emergency Management Australia

P.O Box 1020 Dickson ACT 2602
University of Canberra Innovation Centre
Building 23, University Drive South
Bruce ACT 2617
AUSTRALIA
Tel: <61> (02) 6256 4692
Fax: <61> (02) 6256 4653
E-mail: brian.flanagan@ema.gov.au

Ms Diana GREENSLADE
Oceanographer
Bureau of Meteorology
700 Collins Street
Docklands VIC 3008
GPO BOX 1289
Melbourne VIC 3001
AUSTRALIA
Tel: <61> (3) 9669 4124
Fax: <61> (3) 9669 4660
E-mail: dag@bom.gov.au

Mr Daniel JAKSA
Project & Quality Co-ordinator, Australian Tsunami Warning System
Geospatial & Earth Monitoring Division
Cnr Jerrabomberra Ave & Hindmarsh Drive
Symonston
GPO BOX 378 Canberra ACT 2601
AUSTRALIA
Tel: <61> (02) 6249 9685
Fax: <61> (02) 6249 9986
E-mail: Daniel.Jaksa@ga.gov.au

Mr Robert A. LAWSON
Vice President
Ocean & Atmospheric Programs Naval & Maritime Solutions
Science Applications International Corporation
4065 Hancock Street
San Diego CALIFORNIA 92110
USA
Tel: <858> 826 1166
Fax: <858> 826 1169
E-mail: lawsonra@saic.com

Mr Carl MULLER
Project Manager
Australian Tsunami Warning System
Bureau of Meteorology
700 Collins Street
Docklands VIC 3008
GPO BOX 1289
Melbourne VIC 3001
AUSTRALIA
Tel: <61> (3) 9669 4173
Fax: <61> (3) 9669 4695
E-mail: c.muller@bom.gov.au

Ms Helen PEARCE
Manager, Central Operations
National Meteorological & Oceanographic Centre
Bureau of Meteorology
700 Collins Street
Docklands VIC 3008
GPO BOX 1289
Melbourne VIC 3001
AUSTRALIA
E-mail: h.pearce@bom.gov.au

Mr Chris RYAN
Superintendent, National Meteorological and Oceanographic Centre
Bureau of Meteorology
700 Collins Street
Docklands VIC 3008
GPO BOX 1289
Melbourne VIC 3001
AUSTRALIA
Tel: <61> (3) 9669 4030
Fax: <61> (3) 9662 1222
E-mail: c.ryan@bom.gov.au

Dr Jane WARNE
Supervising Meteorologist
Observations Network Design & Management
Australian Tsunami Warning System Project
Bureau of Meteorology
GPO BOX 1289
Melbourne VIC 3001
AUSTRALIA
Tel: <61> (3) 9669 4721
Fax: <61> (3) 9669 4168
E-mail: j.warne@bom.gov.au

Mr Kelvin WONG
Supervising Meteorologist, Data Management
Bureau of Meteorology
700 Collins Street
Docklands VIC 3008
GPO BOX 1289
Melbourne VIC 3001
AUSTRALIA
Tel: <61> (3) 9669 4227
Fax: <61> (3) 9669 4128
E-mail: k.wong@bom.gov.au

III. OBSERVERS, COUNTRIES NOT MEMBERS OF ICG/PTWS

NAURU

Mr Tyrone DEIYE
Project Manager for ARM Site
Main Government Offices
Yarran District
NAURU
E-mail: tdeiye@cenpac.net.nr

Mr Andrew KAIERUA
Project Manager for ARM Site
Main Government Offices
Yarran District
NAURU
Tel: 674 444 3133
Fax: 674 444 2891
E-mail: akaierua@cenpac.net.nr

NIUE

Mr Speedo HETUTU
Disaster Council Member
Niue
NIUE
Tel: 683 4119
Fax: 683 4385
E-mail: gm.npc@mail.gov.nu

Mr Robert TOGIAMANA
Police Emergency Disaster Management Officer
NIUE
Tel: <683> 4333
Fax: <683> 4324
E-mail: robert.police@mail.gov.nu

SOLOMON ISLANDS

Mr Loti YATES
Director of the National Disaster Management Offices
SOLOMON ISLANDS
Tel: 006 772 7936
Fax: 006 772 4293
E-mail: ndc@solomon.sb

TONGA

Mr Tevita FATAI
Geologist GSU
Ministry of Lands, Survey & Natural Resources
TONGA
Tel: (676) 25508
Fax: (676) 23216
E-mail: tmfatai@yahoo.co.nz and geology@kalianet.to

Mr Moleni TU'UHOLOAKI
Senior Forecaster
Ministry of Civil Aviations,
TONGA Met Services
TONGA
Tel: (676) 35123 or 35355
Fax: (676) 23216 or (676) 35123
E-mail: mtuuholoaki@mca.gov.to

TURKEY

Mr Ahmet C. YALCINER
METU Civil Engineering Department
Ocean Engineering Research Center
06531 Ankara
TURKEY
Tel: <90> (312) 210 5438
Fax: <90> (312) 210 1412
E-mail: yalciner@metu.edu.tr

VANUATU

Mr Johnson BINARU
Ministry of Infrastructure and Public Utilities
PMB 044
Port Vila
VANUATU
Tel: 006 782 2888
Fax: 006 782 4495
E-mail: jbinaru@vanuatu.gov.vu

Mr Job ESAU
National Disaster Management Office
PMB 9014
Port Vila
VANUATU
Tel: 006 782 2392
Fax: 006 782 4465
E-mail: jesau@vanuatu.gov.vu

Ms Esline GARAE
Seismology Section
Department of Geology and Mines
PMB 001
Port Vila
VANUATU
Tel: 006 782 2907
Fax: 006 782 2213
E-mail: esline@vanuatu.gov.vu

IV. INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION / UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION (IOC/UNESCO)

Dr Jane CUNNEEN
ICG/IOTWS Secretariat
P.O. Box 1370
West Perth WA 6872
AUSTRALIA
Tel: <61> (8) 9321 9976
Fax: <61> (8) 9263 2211
E-mail: j.cunneen@bom.gov.au

Mr William A. ERB
Head- Perth Regional Programme Office
c/o Bureau of Meteorology
P.O. Box 1370 West Perth W.A. 6872
AUSTRALIA
Tel: <61> (8) 9226 2899
Fax: <61> (8) 9226 0599
E-mail: w.erb@bom.gov.au

Mr Bernard KILONSKY
IOC/GLOSS
UHSLC/MS.B 317
1000 Pope Road
Honolulu HAWAII 96816
USA
Tel: <1> (808) 956 6574
Fax: <1> (808) 956 4352
E-mail: kilonsky@hawaii.edu

Dr Laura KONG
Director, International Tsunami Information Centre (ITIC)
Director, ICG/PTWS Secretariat
737 Bishop St., Suite 2200
Honolulu HAWAII 96813-3213
USA
Tel: <1> (808) 532 6423
Fax: <1> (808) 532 5576
E-mail: l.kong@unesco.org

Mr Masahiro YAMAMOTO
Senior Tsunami Advisor
UNESCO/IOC
1, rue Miollis
75732 Paris cedex 15
FRANCE
Tel: <33> (1) 45 68 39 60
Fax: <33> (1) 45 68 58 10
E-mail: m.yamamoto@unesco.org

Mr Brian YANAGI
International Tsunami Information Centre (ITIC)
737 Bishop St., Suite 2200
Honolulu HAWAII 96813-3213
USA
Tel: <1> (808) 532 6424
Fax: <1> (808) 532 5576
E-mail: brian.yanagi@noaa.gov
(Also representing the USA)

V. LOCAL SECRETARIAT

Dr Peter DEXTER
Co-President of JCOMM
Ocean Services Section
Weather and Ocean Services Policy Branch
Bureau of Meteorology
GPO Box 1289
Melbourne VIC 3001
AUSTRALIA
Tel: <61> (3) 9669 4870
Fax: <61) (3) 9669 4695
E-mail: p.dexter@bom.gov.au

Ms Pina SOCCIO
Weather and Ocean Services Policy Branch
Bureau of Meteorology
GPO Box 1289
Melbourne VIC 3001
AUSTRALIA
Tel: <61> (3) 9669 4870
Fax: <61) (3) 9669 4575
E-mail: p.soccio@bom.gov.au

Ms Natalie VAN GILS
Weather and Ocean Services Policy Branch
Bureau of Meteorology
GPO Box 1289
Melbourne VIC 3001
AUSTRALIA
Tel: <61> (3) 9669 4551
Fax: <61> (3) 9669 4575
E-mail: n.vangils@bom.gov.au

ANNEX VI

ACTION SHEET BASED ON THE DECISIONS OF ITSU-XX

SUMMARY OF ACTION ITEMS
ITSU-XX
Vina del Mar, Chile
Version 03 May 2006

Responsible for Action:
RED: ITIC or ICG Secretariat
BLUE: PTWC
GREEN: PTWS Chair or Vice-Chair, PTWS Officers
BLACK: Member States, Member State National Contact

Para. No.	Action	Responsible	Deadline / Status
3. PROGRESS IN THE PROGRAMME IMPLEMENTATION			
3.2 National Reports			
37	Australia to provide data from its upgraded Tsunami Alert System (water level, seismic, DART) to PTWC and share all data with countries in the Pacific and Indian oceans.	Australia (3.2)	Status ICG/PTWS-XXI
50	Republic of Korea installing real-time ocean bottom seismometer and borehole seismometer; data to be shared with other countries.	Republic of Korea (3.2)	Status ICG/PTWS-XXI
67	Philippines hosts a training workshop for tsunami modeling.	Philippines (3.2)	November 2005 DONE, reported in Tsunami Newsletter
70	Add tsunami occurrences and sea level observations to National Reports	Member States	National Report, 1 April 2006 rev deadline 7 April 2006
72	National Report for ICG/PTWS-XXI; Henceforth published electronically through PTWS website. Template file available from PTWS web site http://ioc3.unesco.org/ptws	National Contacts	1 April 2006 rev deadline 7 April 2006
3.3 ITIC Director's Report			
82	Make information on Alert Services available to the government officials in charge of Member States' tsunami warning.	ITIC	February 2006
87	Compile summary of TBB	ITIC	Mid June 2006

Para. No.	Action	Responsible	Deadline / Status
	communications posted immediately after the Indian Ocean tsunami and provide this summary through the *Tsunami Newsletter* and the TBB.		
3.4 PTWC Director's Report			
97	Japan sea level data operated by JMA sent to PTWC on 15-minute schedule.	Japan (3.2)	Status ICG/PTWS-XXI
97	Canadian sea level data sent by GOES to WC/ATWC.	Canada (3.2)	Status ICG/PTWS-XXI
98	PMEL transfer SIFT model to PTWC and WC/ATWC to make warnings more accurate through tsunami wave forecast models.	PTWC (3.4)	December 2006
101	Determine if Nov. 17, 2003 forecasts were produced for locations other than Hilo and, if so, how accurate were they?	Chair (3.4)	Report in Tsunami Newsletter August 2006
102	Data from two Japanese cabled deep ocean sensors to PTWC	PTWC Japan (3.5)	Status ICG/PTWS-XXI
3.7 Report on the International Signs and Symbols			
133	Contact ISO to inquire on final decision and inform Member States of the response	ICG Secretariat	March 2006
4. ITSU STRATEGIC PLAN			
4.1 Development of an ITSU Medium-Term Strategy			
141	Draft medium term strategy for PTWS (Resolution ITSU-XX.2)	Inter-sessional Working Group Chair, Australia Member States PTWS Officers (C) PTWC, ITIC	April 2006
143	Invite USA to Chair inter-sessional Working Group 1 (Seismic Measurements, Data Collection and Exchange).		November 2005 Stuart Weinstein (PTWC) is Chair; WG 1 mtg 15-16 March 2006
144	IOC lead assessment of requirements and capacity needs for effective and durable national tsunami warning and mitigation system, upon request from Member State Donors invited to support IOC-led assessment missions.	Australia, NZ (6.2) ICG Secretariat	Australia proposes to conduct in 2006-2007 working closely with IOC ICG Secretariat, and including SOPAC

Para. No.	Action	Responsible	Deadline / Status
146	Inter-sessional WG on the Medium Term Strategy for the PTWS convene at ICG/PTWS-XXI to discuss cross-cutting matters	Australia/Chair (5.3) ICG Secretariat	ICG/PTWS-XXI
4.2 ITSU Review			
150	Request the IOC Executive Council reassess the need for an external review of the PTWS	Chair (?) ICG Secretariat	June 2006
4.4 ITSU Communications Plan			
161	PTWS national contacts to review the list of contact points and remove contacts that are not strictly essential, Reference draft document distributed at ICG/ITSU-XX and available from PTWS web site http://ioc3.unesco.org/ptws	National Contacts	December 2005 On-going
161	Disseminate the 'Communications Plan for the Tsunami Warning System in the Pacific'.	PTWC	February 2006 Electronic distribution of 29 March 2006 update
161	Publish the 'Communications Plan for the Tsunami Warning System in the Pacific' on the PTWS website.	ITIC	February 2006 Present plan, including NWPTA Handbook for NW Pacific and South China Sea, on web site
4.5 Organization of Pacific Wide Tsunami Drill			
163	Design and carry out an end-to-end tsunami exercise for the Pacific Ocean (during the second week in May 2006) as per Recommendation ITSU-XX.3	Tsunami Exercise Task Team, Chair–Australia (3.8)	May 2006, Discussion and final planning at ICG/PTWS-XXI
163	Formal letter announcing the exercise and providing its details composed by Task Team and sent by IOC as soon as possible to highest possible contact within emergency management structure of each Member State to help facilitate participation.	Task Team Chair ICG Secretariat	February 2006 DONE CL2186 6 March 2006
163	Prepare a **Final Report** on the Tsunami Exercise for the IOC Executive Council meeting in June 2006.	Chair (3.8) Task Team Chair ITIC	End of July 2006 (after IOC EC)

Para. No.	Action	Responsible	Deadline / Status
5. OBSERVATIONAL SYSTEMS AND RELATED MATTERS			
5.1 Sea level Observations			
170	Support/assistance in obtaining clearances and permission to deploy USA DART buoys within the territorial waters or EEZs of Member States	National Contacts (where necessary) WG2	On-going
176	Member States to cooperate closely with GLOSS to maintain and upgrade their sea level stations.	National Contacts	On-going
5.2 Seismic Observations			
182	Investigate possible areas of co-operation FDSN	PTWS Officers ITIC Director WG1-Weinstein (3.9)	March 2006 WG 1 meeting, 15-16 March 2006; Summary Report available at PTWS web site http://ioc3.unesco.org/ptws
183	Co-operate with FDSN to establish new seismic stations and to contribute to the FDSN network.	Member States WG1-Weinstein (3.9)	On-going
378	PTWC and ITIC to liaise with FDSN and its cooperating institutions on behalf of ICG/PTWS.	PTWC Director ITIC Director WG1-Weinstein (3.9)	March 2006; On-going WG 1 meeting, 15-16 March 2006
5.3 Data Communications Issues			
186	Coordinate cooperation with the Global Geostationary Meteorological Satellite Data Collection system, relevant GTS managers and committees (as per Recommendation ITSU-XX.2).	PTWS Officers WG2-Bailey (3.10)	On-going
5.4 Other			
196	Provide metadata on national sea level stations to ITIC in support of the XML Sea level Data Station inventory project.	Member States WG2-Bailey (3.10)	March 2006 Planning meeting 28-29 March 2006, IODE Office, Belgium; Real time sea level display services also to be discussed Status given at ICG/PTWS-XXI
197	Contact JCOMMOPS to inform them of the XML project and seek their cooperation	ITIC Director WG2-Bailey (3.10)	March 2006

Para. No.	Action	Responsible	Deadline / Status
6. TRAINING AND EDUCATION			
6.1 ITSU Training Programme: Report on Inter-sessional Activities			
204	ITIC support to tsunami numerical modeling training (Nov. 2005, Philippines) and the North Pacific Tsunami Awareness Workshop (Nov. 2005, Palau).	ITIC (6.1)	Tsunami Modelling Numerical Modeling Training - DONE; May 2006 Numerical Modeling Training - Indian Ocean focus, 8-19 May in Malaysia or 22 May to 2 June in Belgium - information posted to PTWS web site http://ioc3.unesco.org/ptws North Pacific Tsunami Awareness Workshop - planned June 2006 with SOPAC, USA NOAA
6.2 Future ITSU Training Programme			
208	Develop the TsunamiTeacher (see also agenda item 7.2)	ITIC (7.2)	December 2006 Phase 1 to be completed May 2006
213	Member States to inform IOC and ITIC of their future plans for training so that these can be posted to the web.	National Contacts (6.2)	On-going
216	ITIC assistance in organization of Ecuador training courses (March 2006) in operational seismology and tsunami modeling; ITIC Director to inquire with experts on their availability for training course.	ITIC Director (6.1)	November 2005 DONE Puerto Rico (University of Puerto Rico Mayaquez), USA - seismology Mexico (CICESE) - tsunami modeling Planned for July 2006
6.3 Public Education			
217	Incorporate the recent enhancements to school curricula developed by Chile into the English language versions; post the updated information to the ITIC web site.	ITIC Assoc. Dir. ITIC Dir. (7.3)	April 2006
219	Member States to contribute materials for document collection module of TsunamiTeacher, as well as lecture material for the course module.	Member States (7.2)	March 2006

Para. No.	Action	Responsible	Deadline / Status
7. ITSU PUBLICATIONS AND AWARENESS TOOLS			
7.1 Tsunami Newsletter			
221	Continue publication of *Tsunami Newsletter* on a periodicity of three months.	ITIC (7.1)	On-going
222	Member States and organizations to contribute tsunami-related articles for Newsletter.	Member States (7.1)	On-going
7.2 Tsunami Information Kit			
230	Investigate cooperation between PI-GOOS (which has an educational programme called 'SEAREAD') and TsunamiTeacher.	ITIC Director (7.2)	March 2006
232	Materials collected for Tsunami Information Kit included in TsunamiTeacher.	ITIC Director (7.2)	December 2005 DONE; also including SOPAC-PDC-ITIC-PTWC Pacific Tsunami Awareness Kit materials
7.3 ITSU Websites			
239 and 325	Australia willing to fund development of an international web site, hosted by IOC, subject to proposal from Secretariat	See paragraph 326 for required actions.	DONE, Australia funding not required; new web site to be deployed June 2006
326	Invite Member States to assist in the drafting of a proposal for a global tsunami web site that will serve as a central portal to regional and national sites.	ITIC Director ICG Secretariat	31 December 2005 Not applicable, see above
326	Submit a proposal to Australia for consideration	ICG Secretariat	February 2006 Not applicable
241	ICG/PTWS recommendation that an "overall" web site be developed (as per paragraph 239) that would provide a central point of entry into IOC's tsunami programmes.	ITIC Director (7.4) ICG Secretariat	December 2005 New web site to be deployed June 2006
242	Member States to inform ITIC of their URLs of national tsunami-related web sites.	National Contacts	March 2006
7.4 Other			
251	ITIC to make updated English language information brochures available in hardcopy and electronic format	ITIC (7.3)	DONE Electronic versions available on ITIC web site, to be distributed at ICG/PTWS-XXI

Para. No.	Action	Responsible	Deadline / Status
252	Coordination and/or liaison between regional IOC tsunami programmes on newsletters and other information tools.	ITIC Director (7.4?) ICG Secretariat PTWS Officers	On-going
253	Public awareness activities organized within a multi-hazard framework	PTWS Officers National Contacts	On-going
8. REGIONAL AND OTHER TSUNAMI WARNING SYSTEMS			
8.1 Northwest Pacific Tsunami Warning System			
255	Expansion of the NWPTAC to the South China Sea	Japan (4.1) USA Malaysia (Kuala Lumpur meeting)	March 2006 JMA/PTWC Coordination Meeting 14 March 2006; Interim Service start 1 April 2006
257	Obtain information from GE-GLOSS on the status of stations in the South China Sea, the Sea of Okhotsk, and along the Pacific coast of Russia.	Chair (4.1)	June 2006 Required information will be contained in National Reports for GE-GLOSS9
259	PTWC and JMA to provide an interim tsunami advisory service for the South China Sea	PTWC and JMA (4.1)	Immediate Interim Service start 1 April 2006, email notification to MS and through NWPTAC and PTWC Communications Tests; CL2187 dated 10 March 2006
259	JMA to develop a communications plan for South China Sea describing messages, criteria etc. for distribution to concerned countries.	JMA (4.1)	March 2006 Received by ICG Secretariat 25 March 2006
260	Member States wanting to receive interim support to provide national contact information to JMA and PTWC.	Member States (4.1)	1 April 2006 CL2187 dated 10 March 2006
263	Countries in South China Sea currently benefiting from interim reports to ensure that such functions will be assumed by centres within their regions within an agreed-upon period	Countries of the South China Sea Region (4.1)	April 2006
8.2 Central America Pacific Coast Tsunami Warning System			
273	Invite Honduras and Panama to join the ICG/PTWS	Chair (4.2) ICG Secretariat	On-going
273	Invite Mexico to participate more actively in the activities of the ICG/ITSU	Chair (4.2) ICG Secretariat	On-going

Para. No.	Action	Responsible	Deadline / Status
273	Request countries that have both a Gulf/Atlantic and Pacific coast to ensure close cooperation between the Pacific and Caribbean efforts.	Chair (4.2) ICG Secretariat	On-going
275	Organization of joint activities such as workshops and training courses between the ICG/PTWS and CEPREDENAC.	PTWS Officers ICG Secretariat (4.2)	On-going
276	Maintain Inter-sessional WG on the Central American Warning System.	Nicaragua (WG Chair) (8.2)	On-going
8.3 Southwest Pacific Tsunami Warning System			
286	Invite/encourage countries in Southwest Pacific that are currently not members of the IOC and ICG/PTWS to join.	Chair ICG Secretariat Australia (4.3)	On-going
286	ITIC to compile a list of countries in the Southwest Pacific region that are/are not UNESCO, IOC and ICG/PTWS Member States	ITIC	March 2006 DONE, posted to ICG/PTWS Web site
288	SOPAC member countries to undertake further emergency management and public awareness activities.	ICG Secretariat to liaise with SOPAC Australia (4.3)	February 2006
8.4 ICG/IOTWS			
298	Countries operating DART buoys in Pacific and other regions should join 'DART International Partnership' to ensure global standardization	USA, Chile and other Member States as appropriate ICG Secretariat WG2 (3.10)	On-going
8.5 ICG/CARIBE-EWS			
315	Dr von Hillebrande-Andrade and other Caribbean colleagues invited to participate in the ICG/PTWS inter-sessional WGs.	Chair ICG Secretariat	DONE
8.6 ICG/NEAMTWS			
320	Chair or Vice-Chair of ICG/PTWS should participate in meetings of these other groups and vice-versa	Chair Vice-Chair Past Chair USA (Green) and Nicaragua (8.2)	Vice-Chair participated in ICG/IOTWS-II, Past Chairman participated to ICG/NEAMTWS- I and to ICG/CARIBE-EWS-I

Para. No.	Action	Responsible	Deadline / Status
9. EXISTING PARTNERSHIPS AND OPPORTUNITIES FOR NEW ONES			
9.1 Cooperation with the IUGG Tsunami Commission			
331	Organize a workshop in conjunction with the next PTWS session. Unclear if this means April 2006 or fall 2007.	PTWS Officers (9.1) IUGG TC Officers Malaysia (or 4.1?)	May 2006 Malaysia and IOC to co-sponsor Roundtable of Earthquake and Tsunami Risk in the South China Sea Region, Kuala Lumpur, Malaysia 27-28 April 2006 Nuñez and Schindele to contact IUGG TC Chair
9.2 Cooperation with ISDR and IHO			
338	Establish close cooperation between the ICG/PTWS, the WMO and the ISDR.	ICG Secretariat Chair (9.4 / 9.6)	On-going
9.4 Cooperation with CTBTO			
350	CTBTO offered to provide seismic and hydroacoustic station data to PTWC and JMA in real-time to improve the rapidity and efficiency of detection of large earthquakes in the Pacific.	PTWC and JMA requested to report on results WG1, Weinstein (3.9)	Status ICG/ITSU-XXI
9.7 Cooperation with GLOSS			
367	ICG/PTWS Chair or Vice-Chair participate in Sessions of the GLOSS Group of Experts	Chair or designate (3.10)	On-going
9.8 Cooperation with JCOMM			
375	ICG/PTWS Chair and Vice-Chair liaise with coordinators of JCOMM OPA and SPA to discuss cooperation	Chair or Vice-Chair Dexter (9.5)	March 2006
9.9 Other			
381	Ensure tsunami issues are included in the IOC agenda in its continuing participation in GEO	ICG Secretariat	On-going
12. PROGRAMME AND BUDGET			
395	Make national authorities aware of the PTWS programme and its benefits; support the programme by contributing directly to the IOC Trust Fund or by in-kind contributions.	Chair (13) National Contacts	On-going

Para. No.	Action	Responsible	Deadline / Status
13. DATE AND PLACE FOR ICG/PTWS-XXI			
399	Ecuador offered to host ICG/PTWS-XXII in 2007; offer accepted	Ecuador PTWS Officers ICG Secretariat	Oct/Nov 2007 (tentative) **Chair to request confirmation**
14. ELECTION OF CHAIR AND VICE-CHAIR			
403	Election, as from the next session, two Vice-Chairpersons.	Chair ICG Secretariat (15)	**ICG/PTWS-XXII**
15. ADOPTION OF THE SUMMARY REPORT AND RECOMMENDATIONS			
405	Prepare Action Sheet of ICG/ITSU-XX decisions.	Chair (16) ICG Secretariat	31 Oct 2005 DONE, posted to web site March 2006
406	Report on proceedings of ICG/ITSU-XX and ICG/PTWS-XXI Sessions to the 39th Session of the IOC Executive Council	Vice-Chair or Past-Chair	21-28 June 2006
408	For future sessions only adopt the action items, resolutions and recommendations in session; for rest of Summary Report, authors need to submit material prior to Session.	ICG Secretariat PTWS Officers National Contacts	April 2006
	Recommendation ITSU-XX.4 (Annex). Budget prepared for normal inter-sessional period of two years, but to be reviewed and revised as required at PTWS-XXI	Vice-Chair (13) ICG Secretariat	ICG/PTWS-XXI

ANNEX VII

SUMMARIES OF REGIONAL MEETINGS ON TSUNAMI MITIGATION

JOINT STATEMENT
International Round-Table Dialogue on Earthquake and Tsunami Risks in Southeast Asia and the South China Sea Region
27-28 April 2006, Kuala Lumpur, Malaysia

Objectives of the Meeting:

1. To assess earthquake and tsunami and vulnerability in Southeast Asia and the South China Sea region
2. To review the level of preparedness and mitigation measures in place and identify gaps/weaknesses
3. To identify opportunities to strengthen regional and international partnerships, networking and capacity building

Attendees to this International Round-Table Dialogue on Earthquake and Tsunami Risks in Southeast Asia and the South China Sea Region represented the countries of the region, including Australia, Bangladesh, Cambodia, China, India, Indonesia, Pakistan, Malaysia, Maldives, Myanmar, Pakistan, Philippines, Singapore, Thailand, Vietnam, tsunami warning centre and disaster preparedness organizations of the Asian Disaster Preparedness Center (ADPC), Japan Meteorological Agency (JMA), University of Hawaii Sea Level Center (UHSLC), and USA Pacific Tsunami Warning Center (PTWC), seismological and tsunami experts from Canada, Northern Ireland, Russian Federation, Turkey, and the USA, the IOC of UNESCO and its Tsunami Unit, the Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System (ICG/PTWS), the Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWS), the GLOSS Group of Experts, and the International Tsunami Information Centre, and the private sector.

Over a period of one and a half days, Round-Table attendees shared information on the earthquake and tsunami hazards of Southeast Asia and the South China Sea, and the Indian Ocean, discussed the implications of the tsunami hazard on coastal communities and the ways in which to mitigate the earthquake and tsunami hazard in order to save lives and reduce property damage.

Background

In developing an Action Plan, the attendees recognize that arrangements for operation and establishment of international and regional tsunami warning systems are under the leadership of the IOC of UNESCO. IOC coordinates activities globally through tsunami warning and mitigation systems in the Indian Ocean (ICG/IOTWS), the Caribbean and Adjacent Regions (ICG/CARIBE-EWS), and the northeastern Atlantic, Mediterranean, and connected seas (ICG/NEAMTWS), and the long-established ICG/PTWS.

Earthquake and tsunami hazards exist in the Indian Ocean, Andaman Sea, the Philippine Sea, Bohai Sea, East China Sea, South China Sea, Java Sea, Sulawesi [Celebes] Sea, Mindanao Sea, and Sulu Sea. The tsunami travel times across these seas are, in many cases, on the order of only an hour or two and consequently require a dense network of instrumentation and real or near real time data;

In particular, the Twentieth Session of ICG/ITSU [now ICG/PTWS] in October 2005 recognized that the South China Sea region is vulnerable to destructive tsunamis and requested both the PTWC and the JMA provide interim tsunami advisory services for the South China Sea and develop a communication plan for the South China Sea.

Also, the ASEAN Task Force for Tsunami Early Warning identified seismic data (July 2005) and sea level data (April 2006) to be shared amongst Member States to enable the earliest of tsunami warnings.

In addition strong common links exist between the ICG/PTWS and other operational programmes of the IOC and WMO, including the Global Sea Level Observing System (GLOSS), the Global Telecommunication System (GTS), and the global Geostationary Meteorology Satellite System, operated by European Space Agency, the Japan Meteorological Agency, and the US National Oceanic and Atmospheric Administration.

Action Plan

As a result of the Round-Table Dialogue, the following Action Plan was agreed upon:

26. Continue the significant progress on assessing earthquake and tsunami and vulnerability in Southeast Asia and the South China Sea region through the support of national and international research initiatives including historical and paleotsunami assessments.
27. Although substantial progress has been made in some countries with regard to tsunami preparedness and mitigation, there are still some gaps and weaknesses, and the countries within the region should continue efforts to address these shortcomings and to raise the general level of preparedness.
28. Build on the regional partnerships that have been developed and strengthen international partnerships through membership and active participation in ICG/PTWS and/or ICG/IOTWS.
29. Ensure long term sustainability by implementing an end-to-end framework in a multi-hazard context.
30. Urge ICG/PTWS to continue to focus on establishing regional TWS capabilities to cover the South China Sea region.
31. Countries in the region to improve sea level coverage in the South China Sea.
32. Promote the free and open exchange of real time seismic and sea level data and information to be used for national tsunami warning and event monitoring.
33. Southeast Asia and the South China Sea region should utilize or build on the PTWS, IOTWS and other existing organizations and institutions in order to achieve durability.
34. Request each country in the region to provide a 7x24 Tsunami Focal Point to the ICG/PTWS Secretariat, ITIC, to receive tsunami warnings issued by the JMA and PTWC.
35. Countries in the Southeast Asia and the South China Sea region should continue to improve their instrumentation and provide the resulting data and information in real time to PTWC and the JMA.
36. Request the ITIC continue to provide advice on the establishment of National Warning Systems, including especially public awareness and education.
37. Request the WMO and its Member National Meteorological Services continue to support the IOC through warning products and data exchange through its Global Telecommunications System (GTS), and to ensure that the GTS links are adequate for such purposes.
38. Urge capacity building organizations, such as ADPC, to continue their efforts in the region to reduce risk from all disasters, including tsunami.
39. Encourage participation in the PTWS Tsunami Exercise on May 17, 2006.
40. Recommend a follow-up meeting be held in a year’s time to report on progress of this Action Plan.

The attendees expressed their appreciation to the Government of Malaysia through the Ministry of Science, Technology and Innovation and UNESCO-IOC for convening and co-hosting the Round-Table Dialogue, and the Organization of Islamic Conference – Commission on Science and Technology, and the International Tsunami Information Centre for co-sponsoring the Dialogue.

The attendees also requested that the Malaysian National Contact to ICG/PTWS report on this meeting at the ICG/PTWS-XXI in Melbourne on 3-5 May, 2006.

ANNEX VIII

REPORTS FROM THE INTER-SESSIONAL WORKING GROUPS

ICG/PTWS-XXI
INTER-SESSIONAL WORKING GROUP SUMMARY REPORT:
Working Group 1: Seismic Measurements, Data Collection and Exchange
3 May 2006

ICG/PTWS Inter-sessional Working Group 1 (WG1) met on May 2, 2006 at the Melbourne offices of the Australia Bureau of Meteorology to discuss and formulate recommendations concerning measurement of seismic parameters, seismic data collection and exchange for ICG/PTWS-XXI.

Attending:
Stuart A. Weinstein, USA (Chair)
Alexei Gorbatov, Australia
Spiro Spiliopoulos, Australia
Osamu Kamigaichi, Japan
Francois Schindele, France
Dominique Reymond, France
Wilfred Strauch, Nicaragua
Ken Gledhill, New Zealand
Garry Rogers, Canada
W. T. Wong, China
Charles McCreery, USA
Masahiro Yamamoto, IOC

WG1 Terms of Reference

The WG1 charge, as stated in the ICG/ITSU-XX Summary Report, is:

- *To review and report on existing arrangements with regard to seismic measurements, data collection and exchange*
- *To advise on how best to ensure that all earthquakes of magnitude 6 or greater can be reliably located and sized in a timely manner*
- *To review and make recommendations regarding upgrading and enhancements to the PTWS network, communications, processing and analysis to further reduce the time required for an earthquake source characterization to meet desired warning responses.*

Motivations for the discussion of issues related to seismic measurements, data collection and exchange.

1) To ensure that the warning centres are using the most prudent seismological analysis consistent with their operational mission and to facilitate exchange of ideas amongst the warning centers
2) To ensure that nations in the Pacific Basin with an elevated local tsunami hazard will not simply fall through the cracks because the PTWC or regional warning centres can not adequately warn for a local tsunami threat outside their local area.
3) To recognize the key role played by data providers such as providing the volume of high quality broadband seismic data to the warning centres and ensure that these data providers will have continued support to maintain and expand their existing networks
4) To recognize the tsunami warning system potential of other technologies not previously integrated into the PTWS.

Perhaps one of the most important discussions to take place concerned the existence of new tsunami warning systems (Nicaragua) and those currently under development (El Salvador). It was quickly realized that more Member States had some capability for local tsunami warning than thought. Clearly, WG1 needs an accounting of existing tsunami warning seismic networks before it can make informed decisions as to how to leverage existing assets and where or what additional assets may be needed. Further discussions brought to light that the development of analysis software based on an open-source and platform independent model by existing warning centres can help kick-start national tsunami warning centres.

Another issue that generated much discussion was the use of technologies such as GPS or strong motion sensor arrays in the context of tsunami warning. Much along the same lines there was also discussion regarding new cabled geo-ocean observing systems being installed around the world [Neptune (~2000-km cable), Japan Tokai (~200-km cable)].

Categories of Recommendations

The 20 recommendations made at the WG1 inter-sessional meeting in Honolulu (Mar. 15-16) meeting tended to fall in a few categories, and the suggestions/additional recommendations made in Melbourne also fall into these same categories. These categories are:

- Infrastructure of Seismic Networks/Data Access
- Filling in The Gaps of The PTWS (in terms of both instrumentation and coverage of the PTWS)
- New technologies for Tsunami Warning
- Sharing Operational Techniques and Procedures
- Other Recommendations

Specific Recommendations of WG1 to ICG/PTWS-XXI
In this section the recommendations are listed by category.

Infrastructure of Seismic Networks/Data Access

1. The WG recognized that the international tsunami warning system depends largely upon the real-time seismic waveforms made available by the Global Seismographic Network (GSN), and noted that this scientific network is funded largely by the US National Science Foundation and the US Geological Survey. The WG also recognized the important contributions made by international and Member State organizations toward this Network. However, the WG noted that the function of these organizations is primarily for earthquake monitoring and research, and not tsunami warning. The WG thus strongly stated that it is essential that the GSN and other contributing networks should be sustained at high levels of operational reliability for tsunami warning.
2. The WG stated that open and unrestricted access to real-time data is essential for both research and operations. These data include seismic and sea level time series.
3. The CTBTO presently provides its primary station and hydro-acoustic data to tsunami warning centres. The WG noted its high value as presented by the JMA and PTWC, and recommended that this data flow be continued. The WG also recognized the importance of auxiliary station data for tsunami warning, and recommended that these be also made available in real time.
4. The CTBTO shares its Global Communications Infrastructure (GCI) with the GSN, and this telemetry is vital for tsunami warning systems. The WG recommended that the IOC recognize and encourage that this important cooperation with CTBTO continue.
5. The WG recognized the world wide coverage and open data availability of stations of the International Federation of Digital Seismograph Networks (FDSN), and recommended that global, regional, and local Tsunami Warning Systems work with FDSN and its member networks to incorporate real-time data from available FDSN stations.
6. The WG recognized that all seismic coverage is from land-based seismic stations, and that almost no coverage is available seaward from the major seismogenic zones around the Pacific. The WG noted that this is a fundamental gap in the PTWS' ability and speed to characterize

the earthquake source in near real-time. It was recognized that extensive deep-ocean tsunami infrastructure is being developed and deployed to monitor sea levels in real time. The WG recommended that enhancing these systems with seafloor seismic and acoustic sensors should be explored and developed.

7. The WG discussed the requirements for high-quality real-time seismic waveforms. For this, the concepts of waveform completeness and timeliness of receipt were agreed to be the most important metrics. Complete data must have little or no gaps. Latency should be as small as reasonable. The WG recommended definitions of Completeness and Latency to facilitate the discussion of seismic transmission standards. It was recognized that Latency is comprised of several components; data record size (buffer), telemetry (including internet) latency, data reformatting and server latency. The WG recommended that transmission latency should be defined as the difference between current time and the time of the last datum received in the most recent packet, emphasizing the vertical 20sps channel. Networks should note the respective data record size for channels. Measures of latency should include median statistics to avoid effects of large outliers. Data servers should measure and note server latency due to data reformatting or internal buffers. The amount of tolerable latency depends on need. It is recommended that for teleseismic processing, buffer latency of twenty seconds is desirable and a buffer latency of second is desirable for local seismic processing.
8. As National systems develop their capabilities, their data should be shared in real time with the regional centres to simultaneously enhance the capabilities of the regional and basin-wide warning centres.
9. The WG recognized that the best seismometers for determining the tsunamigenic potential of an earthquake are Streckeisen STS-1. Therefore, the WG stated that is incumbent for Member States with STS-1 sensors to share the data in real time.

Filling in the Gaps of the PTWS

10. The Pacific Tsunami Warning Center provides timely international tsunami warnings for tele- and regional tsunamis. However, given that the time elapsed before an initial bulletin is issued by the PTWC may range from 10 to 20 minutes, the WG recognized the limitations of the PTWC to provide local tsunami warnings (outside of Hawaii), and recommended each Member State to consider national or coordinated sub-regional tsunami warning centers to address local tsunami hazards. The WG encourages Member States with local capabilities to share their know-how and experience.
11. The WG recognized the high value of providing guidance on the establishment of local warning capabilities, and recommended this issue be addressed by the Working Group on the Medium-Term Strategy for the Pacific Tsunami Warning and Mitigation System.
12. The Southwest Pacific faces a significant threat from locally-generated tsunamis that is not currently addressed by any local warning system. The WG reaffirmed the Action Plan developed by eight SOPAC Member States during the South Pacific Tsunami Awareness Workshop in July 2004.
13. Countries along the Middle America Trench face a significant threat from locally-generated tsunamis and in some cases, this threat is not currently addressed by any local warning system. The WG encouraged the Working Group for the Central America – Pacific Coast Tsunami Warning System to actively continue its activities to enable the timely dissemination of local warnings to coastal populations.
14. Produce, keep updated and distributed via a web based service a map showing the relevant instrumentation networks for all Member States. The IOC is to conduct a survey of the Member States to retrieve this information. GeoScience Australia has suggested a willingness to compile the information from this survey into a database. Member States should then send updates on their capabilities to GeoScience Australia.
15. The WG recognized that there currently are significant Internet and telemetry bandwidth limitations into PTWC which restricts bringing available, high-quality seismic, hydroacoustic, GPS and other relevant real-time continuous data for tsunami warning operations. The WG recommends that these limitations be reviewed and rectified at PTWC and at other TWS to assure adequate, dedicated bandwidth for available data flow.

16. The WG recognized and recommended that the GSN constitute the basis for the Pacific Core Network, encouraged the designation of additional real-time FDSN stations in the Core Network, and agreed that additional stations to densify the network, such as in the Southwest Pacific, South China Sea, and seaward of major seismogenic zones, will be very valuable.

New technologies for Tsunami Warning

17. The WG recognized GPS to be a promising technology for quickly measuring displacements resulting from earthquakes in real time. Such technology is potentially very useful to address the local tsunami warning problem and great global earthquakes. The WG recommended that further research was needed to evaluate the use of GPS for tsunami warning methodologies.
18. The WG was concerned that STS-1 sensors are no longer being manufactured, and that no adequate replacement is in sight. Furthermore, existing deployed sensors are aging. The WG stated that it is necessary for the continued integrity of the tsunami warning system that a successor be developed as soon as possible.
19. Operational tsunami warning should take advantage of new cabled geo-ocean observing systems going in around the world. [Neptune (~2000-km cable), Japan Tokai (~200-km cable)]. To date the tsunami warning centres have not been involved in the planning of these systems. It is recommended that the IOC facilitate communication between the warning centres and the groups deploying these deep sea observing systems.
20. The tsunami warning system should explore the use of strong motion sensor arrays to rapidly determine the size and nature of the rupture of large earthquakes. Modeling should be conducted to establish criteria for assessing the appropriate thresholds for ground accelerations recorded by these arrays at which the genesis of a destructive tsunami is likely.
21. The tsunami warning system should explore the use of broadband sensor arrays to determine earthquake rupture characteristics.

Sharing Operational Techniques and Procedures

22. The WG highly recommended that regular scientific symposia be convened to focus on improving tsunami warning systems and their operational procedures. The WG noted that the IUGG Tsunami Commission has convened such meetings on tsunami research, but not on operational systems, and further noted the need and high value for such symposia on real-time seismology.
23. The WG recognized that research plays a fundamental role in developing better ways of characterizing earthquakes and their potential for tsunamigenesis, and that it is critical that this research be developed into operational tools. The WG recommended that these tools should be openly shared with earthquake monitoring centres and tsunami warning centres.
24. Existing TWCs should make their operational software available to developing TWCs. TWCs should move towards more modular, portable, open-source, platform-independent software to help facilitate this type of exchange. The PTWC is beginning this process with some of its operational software.

Other Recommendations

25. The WG recognized that additional threats from tsunamis are generated by landslides, volcanic explosions, and meteorite impacts, but noted that current tsunami warning systems cannot adequately warn for these events. The WG recommended that further evaluation of these threats is merited.
26. The WG identified the strong need for synergy between other ICG Seismic Working Groups in the Indian Ocean, Caribbean and Adjacent Regions, and the North-eastern Atlantic, Mediterranean, and Connected Seas, and called for the IOC to take a leadership role in integrating and coordinating common activities.

ICG/PTWS-XXI
INTER-SESSIONAL WORKING GROUP SUMMARY REPORT:
Working Group 2: Sea Level Measurement, Data Collection & Exchange
1-2 MAY 2006

ICG/ITSU-XX Inter-sessional Working Group Two (WG2) met on May 1 and 2, 2006 at the Melbourne offices of the Australia Bureau of Meteorology to discuss sea level data issues and formulate recommendations for ICG/PTWS-XXI. Rick Bailey, Chair of the ICG/PTWS Working Group 2, opened the meeting. He welcomed the participants to the meeting and provided a brief introduction. The meeting was held jointly with the ICG/IOTWS Working Group Two on Sea Level Measurement, Data Collection & Exchange.

The meeting was attended by about 40 scientists and government officials representing PTWS and IOTWS Member States, Organizations, and other Agencies and Universities. The Meeting Agenda is provided in Annex I, List of Participants in Annex II, and

Agenda sessions focused on;

- Sea Level Data Requirements for Tsunami Monitoring and Warning
- Sea Level Network Design Principles
- Sea Level Measurement Technology: Tide gauges, Deep Ocean Tsunami Buoys, and other instrumentation
- Sea Level Data Exchange & Archival
- Intra- and Inter-Ocean Basin Coordination

Each Session consisted of informational presentations followed by discussion. ICG/PTWS and ICG/IOTWS Breakout Sessions were included to discuss basin specific requirements of the sea level network (coastal tide gauge and tsunami data buoy), review the sea level network design plan, and discuss the coordination and status of ongoing arrangements and enhancements.

Comments on this report were also received from attendees of ICG/PTWS-XXI including several delegates representing the Pacific Island Countries.

WG2 Terms of Reference

The WG2 charge, as stated in the ICG/ITSU-XX Summary Report, is:

- *To review and report on existing arrangements with regard to sea level data collection and exchange.*
- *To liaise with CBS/WMO/JCOMM and relevant Expert Teams to develop a more effective data representation and code form for exchange of sea level data and to conduct test of latency (timeliness) of GTS transmissions.*
- *To consider desirable additional sites enhancement.*
- *To coordinate plans for sea level observing sensitivity tests to understand the optimal, effective PTWS sea level network.*
- *To review and report on various means of transmitting sea level data to warning centres.*

Objectives of the Joint Meeting

In order to accomplish the work and to synergise the activities of the Indian Ocean through the sharing of experience and knowledge of the Pacific sea level activities in support of tsunami monitoring, WG2 adopted the following Objectives for the Meeting:

- Review ToRs and Membership

- Coordinate and share expertise on general sea level data requirements and network design principles
- Review sea level measurement technologies
- Agree on data exchange protocols and standards
- Review data display tools, etc
- Discuss ocean basin specific issues in respective working groups
- Agree on mechanisms to coordinate individual WG/ocean basin activities

These Objectives provided the motivations for the discussion of issues related to sea level measurements, data collection and exchange.

Review ToRs and Membership

WG2 reviewed the ICG/ITSU-XX WG2 Terms of Reference and agreed to Revised Terms of Reference as follows:

- Review and report on existing arrangements with regard to sea level data collection and exchange
- Ongoing review and monitoring of status of Pacific Ocean sea level networks related to tsunami observation.
- Coordinate plans for sea level observing sensitivity tests to understand the optimal, effective PTWS sea level network and associated technologies.
- Liaise with other sea level measurement, data collection and exchange working groups from other ocean basins, as well as other working groups within ICG/PTWS to coordinate and ensure efficient and effective sea level observations for tsunami warning.
- Liaise with CBS/WMO/JCOMM and relevant Expert Teams to develop a more effective data representation and code form for the exchange of sea level data (standards, metadata requirements)
- Review and report on various means of transmitting sea level data to warning centres and to conduct test of latency (timeliness) of GTS transmissions.

Working Group Two membership:
Australia (Chair, Bailey), New Zealand, United States, Japan, Russia, Malaysia, Chile, Canada, Chair, ICG/IOPTWS WG2 Chair, International Tsunameter Partnership, GLOSS representative

> **Recommendation:** ICG/PTWS WG2 continue during inter-sessional period and meet prior to next ICG/PTWS to ensure coordination and ongoing focus on Pacific Ocean issues by members in the region.

Under the topic of Sea Level Data Requirements for Tsunami Monitoring and Warning, WG2 noted the following Action and Recommendation:

WG2 discussed the needs of sea level data for tsunami monitoring and warning, and recommended that the highest priorities are Operational Tsunami Detection & Warning and Modeling & Forecasting.

- Operational Tsunami Detection & Warning
    - Verification
    - Including “all clear”
- Modeling & Forecasting
    - Warning
    - Hazard & vulnerability assessment
    - Historical data and metadata
- Post Event Analysis

    - Defining terms – run-up, amplitude, arrival time (initial vs maximum), period, inundation distance, etc
    - Data archiving and access
- Longer-Term Scientific Understanding & Forecasting of Tsunami

Action: Seek further input from modelling working groups on data requirements for warning and forecasting
Recommendation: Include feedback from post event analyses into ongoing review of network design

Under the topic of Sea Level Network Design Principles, WG2 noted the following Action and Recommendations

WG2 discussed the components of sea level networks, and identified the following that need to be addressed for the design of an optimal monitoring network for tsunamis:

- Sampling interval
- Accuracy/resolution
- Frequency of transmission
- Spatial density
- Data loss thresholds
- Optimal siting (open ocean vs. coastal vs. island vs. harbour)

The WG noted however, that

- No one solution fits all requirements!
- Need for the statement of a minimum set of specifications for interoperability, taking into account
    - Different regional or sub-regional requirements based on tsunami hazard – network may need to be more dense in some regions (for example, in sub-regions where local tsunamis are a hazard)
    - Identification of optimal targets (e.g. 1-2 Hz sampling)
- Need for the identification of minimum wave detection thresholds for tsunamis (including warning cancellation)
    - 1cm in deep water,
    - 20 to 30cm at coastal sites,
- Need to quantify uncertainty in sea level time series
    - Deep Ocean – 0.5 to 1cm?
    - Coastal – 1 to 2cm (not absolute)?

The WG acknowledged the high value of the GLOSS tide gauge network for providing regional sea level data coverage in support of tsunami warning, and recognized that the GLOSS network should comprise, at least, a subset of the Core Sea Level Network for tsunami detection.

The GLOSS representative, Bernie Kilonsky of the University of Hawaii Sea Level Centre, provided further information about the programme, reporting that in addition to offering in-situ sea level gauges, it also assists ICGs to set data standards, offers training courses, technical visits, technical manuals and training material, and holds workshops on special issues.

The GLOSS representative informed the Working Group on the activities of the Indian Ocean concerning the need for more densely spaced data networks to adequately monitor coastlines with significant tsunami hazards such as the western and southern parts of Indonesia and in the Makran source area of the Arabian Sea. He presented some proposed preliminary specifications for in situ sea level sites within 1 hour travel time and/or 100 km of tsunami generation areas Important features of this new standard, which are proposed by the ICG/NEAMTWS and ICG/CARIBE-EWS where local tsunami hazards are a large concern, are:

Sub-regional

- A sampling of 15 second averages and a continuous transmission cycle of 5 minutes for sites within 1 hour travel time of the tsunamigenic zones,
- Immediate re-transmission via WMO's GTS to JMA, PTWC, and other appropriate warning centres. (The European and Japans' geostationary meteorological satellites can not be used as they are limited to a 15 minute transmission cycle.)

National

- A sampling of 15 second averages and a continuous or 1 minute transmission cycle for sites within 100 km of the tsunamigenic zones.
- Immediate re-transmission via WMO's GTS to JMA, PTWC, and other appropriate warning centres.
- Additionally, it is recommended that when possible these sites be configured as existing multi-purpose coastal sea level stations (for sustainability) and when appropriate be incorporated into the CORE IOTWS.

The WG then further considered the importance of how to maintain and sustain a tsunami sea level network for infrequent hazards such as tsunami. Members of the WG2 noted that the sea level gauge specifications for tsunami detection and monitoring were less than for climate change detection. Therefore tsunami gauges were cheaper to install, making it also possible for denser networks due to cost savings.

Action: Joint WG to coordinate development of network design principles by ICG/IOTWS-III in Bali in July 2006 (Chair Jane Warne, Australia). This should consider the new proposed standards for sea level sites within 1 hour tsunami travel time and/or 100 km of tsunami generation areas, and the implications of these standards in terms of network design for the Pacific

Recommendation: Wherever possible and in the interim sea level stations should conform to GLOSS climate related standards, but the WG noted that requirements for tsunami detection are less stringent so that sea level stations could be installed at less cost where critically needed specifically for tsunami warning guidance.

Recommendation: Wherever possible, installation should be of multi-purpose observing sites to facilitate the long-term sustainability of the observing network

Action: Bernie Kilonsky to advise by ICG/IOTWS-III in Bali July 2006 the additional cost of making a typical tide gauge, which is suitable for tsunami detection, also capable of monitoring sea level for climate change detection.

Under the topic of Sea Level Measurement Technology, WG2 noted the following Action:

The WG discussed the various present and future technologies available for measuring tsunami waves, and the plans of various Member States, include the USA, New Zealand, Australia, Russian Federation, Japan, and ASEAN countries (as presented by Malaysia) to enhance the monitoring networks in the Pacific. It was recognized that a significant amount of activities is currently taking place so that coordination is highly desirable.

- Tide gauges
    - Multiple roles (climate, tsunami, tides)
    - Alternative technologies now being trailed
- Deep-ocean buoys
    - US plans
    - New manufacturers
    - International Tsunameter Partnership

- Other
    - HF radar, altimeters, run-up gauges, cameras, accelerometers on ships, GPS buoys, fibre-optic cables, etc
    - Need ongoing review of new developments

Action: Need to coordinate and communicate outcomes from evaluations of existing and new technologies (e.g. radar)

Under the topic of Data Exchange, Display & Archival, WG2 noted the following Action and Recommendation:

WG2 was informed of the various data formats of national and international networks, transmission processes, data archiving, decode and display capabilities in operation, and discussed the feasibility and desirability for standardization of the different operational schemes. These include:

- Historically non-standardisation of sea level stations and data collection and transmission formats has been the norm. The meeting noted the initiatives by IOC (IODE, GLOSS, ITIC) and PTWC to improve and simplify accessibility, but which were not discussed in any detail:
    - Two Meetings: Oostende, Belgium, 28-29 March 2006
        - Sea Level Metadata Web Service Demonstrator Project (IOC-INF 1226)
        - ODINAFRICA Sea Level Data Facility Project (IOC-INF 1227)

- Satellite Data Transmission
    - Need to consider the capability of some satellite communication systems is limited (e.g. GOES)
- Archival of Sea Level Data
    - USA archiving historical DART data at NGDC/WDC-SEG Tsunamis
    - USA efforts to start to archive real-time, historical, and event data at World Data Centre SEG
- Decode and Display Tools by PTWC
    - Watertool used by PTWC operationally; TideTool follows Watertool
    - TideTool developed for IO operations using GTS
    - TideTool developed for IO using Internet (non-operational) – ODINAFRICA
    - TideTool utilizes open-source, freely-available software

Action: ICG/IOTWS WG2 and ICG/PTWS WG2 coordinate efforts within basins to provide data to WDC (Chairs)

Recommendation: WG2 recommended the global adoption of the CREX Code for the transmission of sea level data over the WMO GTS

Action: Joint ICG/IOTWS WG2 and ICG/PTWS WG2 Sub-WG to review tables, metadata
    - Draft revisions end of June for joint review
    - Table ICG/IOTWS-III in Bali end of July

Members: Australia (Joint Sub-WG Chair, Jane Warne), New Zealand, Japan, Russia, PTWC, ITIC

Under the topic of Intra- and Inter-Ocean Basin Coordination, WG2 noted the following Actions and Recommendations:

The WG noted several activities taking place to further the enhancement of sea level networks to support tsunami warnings. These include discussions taking place between Australia and the USA on deployment of "DART" buoys in SW Pacific Ocean, the SW Pacific Island Countries Tsunami Workshop which gathered technical representatives and national disaster managers to discuss ways in which to increase tsunami mitigation activities, and the continuing, coordinating discussions between Australia and New Zealand on tide gauge installations. National representatives provided presentations on activities and plans.

Under the sub-topic of Sea Level Network Implementation Coordination, WG2 noted the following Actions and Recommendations,

Action: Develop template by end of May 2006 for Pacific Ocean nations to provide status information and national plans for deployments by end of July 2006 to facilitate status monitoring, maintenance and development of sea level network programs (Jane Warne, Australia and National Representatives)

Action: Coordinate this activity with ITIC with view to ongoing maintenance and access to database (ICG/PTWS Chair, Rick Bailey)

Recommendation: ICG/PTWS WG Chairs participate on Medium Term Strategy WG to ensure coordination on status and developments in respective areas

Recommendation: ICG/PTWS WG2 reviewed the ToR's of the International DART partnership (Annex II), and recommended that the ICG/PTWS endorse the concept of an International Tsunameter Partnership to ensure the interoperability of deep-ocean measurements and coordination of deployment opportunities

Under the sub-topic of Inter-Ocean Implementation Coordination, WG2 noted the following Recommendations,

Recommendation: Chair of ICG/IOTWS WG2 and Chair of ICG/PTWS WG2 to help coordinate between basins and identify joint issues.

Recommendation: Respective ICG/PTWS and IOTWS WG2 chairs (or their representatives) to participate in GLOSS meetings to facilitate coordination of requirements

ANNEX I: WORKING GROUP TWO PROVISIONAL AGENDA

Intergovernmental Coordination Group
Pacific Tsunami Warning System (ICG/PTWS)
Working Group 2 Inter-Sessional Meeting
Sea Level Measurement, Data Collection and Exchange
Melbourne 1-2 May 2006

Monday, 1st May

Time	Item	Comments
0830	***Morning Tea/Registration***	Plenary
0915	**Session Organisation** – Introductions – Confirmation of Representatives and Delegates – Terms of Reference – Work Group and Meeting Organisation and Responsibilities – Review of Agenda and Timetable	Joint with ICG/IOTWS WG2
1000	**Sea Level Data Requirements for Tsunami Monitoring and Warning** – Operational Tsunami Detection and Warning – Modelling and Forecasting – Post Event Analysis – Longer Term Scientific Understanding and Forecasting of Tsunami.	Joint with ICG/IOTWS WG2 and Modelling and Warning WGs
1100	**Sea Level Network Design Principles** – Sampling interval – Accuracy/Resolution – Frequency of Transmission – Optimal siting (Open Ocean vs Coastal vs Island vs Harbour)	Joint with ICG/IOTWS WG2 and Modelling and Warning WGs
1200	***Lunch***	
1330	**Sea Level Measurement Technology: Tide gauges** – Instrument Requirements and Standards (tsunami stand-alone, GLOSS/climate, or other multi-role or "research" applications) – Instrument Types and Experiences	Joint with ICG/IOTWS WG2
1415	**Sea Level Measurement Technology: Deep Ocean Tsunami Buoys** – Instrument Requirements and Standards (including special "event" modes) – Instrument Types and Experiences	Joint with ICG/IOTWS WG2
1500	***Afternoon Tea***	
1530	**Sea Level Measurement Technology: Other** (e.g. New/Novel, GPS, satellite, etc) - Discussion	Joint with ICG/IOTWS WG2
1600	**Respective WG Breakouts** – Terms of Reference Review – Mode of operation – Day's issues/Planning for Day 2	
1700	Reception	

Tuesday, 2nd May

0900	**ICG/IOTWS WG2 Breakout Session** – Review of Previous Meeting Action Items – Tide Gauge Network o Status and national plans – Tsunami Data Buoy Network o Status and national plans o Agreement on "core" network o Status reporting o US offer of DART Buoy deployments o Deployment opportunities/collaboration – Sea Level Network Design Review – Coordination/Status Reporting – Action Items	
1030	***Morning Tea***	
1100	**International Deep-Ocean Buoy Partnership Breakout Session** – Planning – Supply and deployment issues – Actions	
1200	***Lunch***	
1330	**ICG/PTWS WG2 Breakout Session** – Tide Gauge Network o Status and national plans – Tsunami Data Buoy Network o Status and national plans o Agreement on "core" network o Status reporting o Deployment opportunities/collaboration – Sea Level Network Design Review – Coordination/Status Reporting – Action Items	
1430	**Sea Level Data Exchange & Archival** – International Data Exchange Protocols, Communications Channels and Message Formats – Data Quality Assurance – Global Data Archiving	Joint with ICG/IOTWS WG2
1530	***Afternoon Tea***	
1600	**Intra- and Inter-Ocean Basin Coordination** – Summaries from Breakout Sessions – Relationships to other international forums (e.g. JCOMM, GLOSS, DBCP, etc) – Coordination mechanisms	Joint with ICG/IOTWS WG2
1700	***Close***	

ANNEX II: LIST OF PARTICIPANTS

No Participant List was provided by the WG Chair

ANNEX III: DRAFT TERMS OF REFERENCE FOR THE "INTERNATIONAL TSUNAMETER PARTNERSHIP

International Tsunameter Partnership

Terms of Reference
(DRAFT February 2006)

1. **Shared Vision**

1.1 Tsunameters are instruments that measure tsunamis in the open ocean. To deliver tsunami measurements in real-time requires that a tsunameter be coupled to a highly sophisticated communication system to report the passage of tsunami in deep ocean waters to tsunami warning centers. For the purposes of this Terms of Reference, a tsunameter is a real-time reporting tsunameter.

1.2 In the aftermath of the Indian Ocean tsunami of 26 December 2004 a number of countries have announced national plans to operate tsunameters or increase the number of tsunameters they operate in pursuit of our common goal of preserving lives and property. Over the next few years the number of tsunameters deployed globally are expected to increase from less than ten in 2005 to eighty or more.

1.3 Tsunameters are critical to the rapid detection and forecast of tsunamis.

1.4 The Intergovernmental Coordination Group of the Intergovernmental Oceanographic Commission's Indian Ocean Tsunami Warning and Mitigation System established the International Tsunameter Partnership (Partnership) to create a voluntary, non-legally binding framework for international cooperation on the research, development, production, deployment, operation and maintenance of tsunameter instruments, buoys and moorings. The Partnership aims to directly support the establishment, effectiveness and on-going viability and enhancement of operational tsunami detection and warning systems, including the Indian Ocean Tsunami Warning and Mitigation System (IOTWS) and the Pacific Ocean Tsunami Warning and Mitigation System (PTWS) and other tsunami warning systems as they are established.

1.5 The Partners recognise that the success of regional tsunami warning systems depends on close collaboration among IOC member states in technology development and transfer; data and information sharing; and operations. Partners commit to sharing information about research, development, production, operation and maintenance to the maximum extent possible.

1.6 The Partners recognise that the regional tsunami warning and mitigation systems operate under the auspices of the Intergovernmental Oceanographic Commission (IOC) of UNESCO.

1.7 The Partners note also that IOC / UNESCO is the competent international organisation in the field of transfer of marine technology for provision of advice on Part XIV of the 1982 United Nations Convention on the Law of the Sea (UNCLOS). The Partnership draws upon the IOC Criteria and Guidelines on the Transfer of Marine Technology developed by the IOC Advisory Body of Experts on the Law of the Sea and adopted by the IOC Assembly through Resolution XXII-12 at its 22nd session in 2003.

2. **Purposes**

The purposes of the Partnership are to:

- establish, coordinate and support international tsunameter research and development efforts, including joint activities;

- set common tsunameter standards, including performance standards and testing and calibration protocols, to ensure that designers and operators of tsunami warning systems can rely on the consistency, comparability and availability of tsunameter data to the maximum extent possible;

- provide input as appropriate to sea level observation network design with a view to optimizing the contribution of tsunameter instruments to the operational and cost effectiveness of tsunami warning systems;

- maximise the sharing of tsunameter technology and cooperation among Partners and with suppliers of tsunameter equipment and components to achieve secure global supplies of high quality systems;

- cooperate where appropriate on the testing and calibration of tsunameter instruments, buoys and moorings;

- maximise opportunities for coordination and cooperation among Partners with regards to the siting, ship access, deployment, operation, maintenance and support of tsunameter systems; and

- help build capacity among Partners to accelerate the viability and success of regional tsunami warning systems.

3. **Common Tsunameter Standards**

Partners will collaborate to maximise the benefits of tsunameter standardisation. These benefits include, among others, the promotion of data consistency, reliability, durability, interoperability, and the facilitation of technology sharing among different economies. In seeking to maximise standardisation with regard to tsunameter technology, buoys, and moorings, the Partnership shall take into account differing regional geographical and operational environments. For example, tsunameters typically deployed in high latitude environments must be able to withstand more severe ocean conditions than buoys deployed in mid-latitude or tropical waters. Some areas require surviving a cyclone or hurricane. And tsunameters deployed in some operational environments face greater risk of anthropogenic interference and harm.

4. **Research, Development and Production**

4.1 Tsunameters are highly sophisticated systems and will be operated by a limited number of countries in small total global numbers, taking into account the global geographical coverage and proximity to tsunami generation zones. There is great potential for communal benefits to be gained from pooling research, development and production activities where possible and appropriate, and for collectively working to ensure viable and trusted long term and cost effective sources of supply, whether the technologies involved are sourced from public or private sectors.

4.2 The unique nature of the tsunami threat makes it the most challenging of all coastal hazards to detect and warn against. Partners agree that cooperation on tsunami detection research and

development has national, regional, and global benefits in our common goal of establishing effective and durable regional tsunami warning systems that will save lives and protect property.

4.3 Partners will exchange technical information and collaborate in the research, development, and production of tsunameter systems to achieve important benefits in standardisation, agility, efficiency, effectiveness, and redundancy that will further the success and durability of tsunami warning systems.

5. Operations

The Partners recognise that the effectiveness of their national tsunami warning efforts is greatly enhanced through integration with regional tsunami warning systems. The Partners acknowledge the benefits to be gained from collaboration in siting, ship access, deployment, maintenance, and other forms of support for tsunameters in terms of increased detection coverage, and efficiencies as well as reduced operational costs.

6. Organisation

6.1 The Partnership shall meet as a single Working Group with a Chair and Vice-Chair. The Working Group shall address policy, technical and operational matters relating to the Partnership. The Working Group may establish sub-committees to address specific matters for referral back to the Working Group. Sub-committee leaders may be invited to meetings to present recommendations. The Working Group shall produce and adopt an annual report of the Partnership's activities, which shall be provided upon adoption to IOC. It is desirable that the Working Group meets at least semi-annually.

6.2 Working Group members shall be country representatives, who may be supported by a delegation. It is desirable that Working Group members be well versed in the policy and technical issues related to tsunami detection and warning systems.

6.3 The Partnership shall operate by consensus among members. At meetings of the Working Group, the Chair shall ascertain whether consensus has been reached on proposals before the group. Consensus is the absence of stated objection. Although unanimity is not necessary, the Chair is required to declare that there is no consensus if there is a stated objection to approve a proposal under consideration.

6.4 The Working Group may agree if so required on additional rules of procedure at its first or subsequent meetings.

6.6 The Chair, working with the Vice Chair, shall coordinate the work of the Partnership, coordinate activities of any work teams that are established, and prepare reports. Partners request that the IOC provide Secretariat support to organize and facilitate meetings.

7. Support

7.1 Each Partner will bring significant value in terms of critical resources to the Partnership. Work Group members should either own, as part of an operational tsunami warning system, either own and operate a tsunameter or intend to own and operate a tsunameter in the immediate future.

7.2 Support for tsunameter operations implies multi-year national contributions of critical resources to the domestic research, development, operations and maintenance of tsunameter. Critical resources are defined as including funding for national research and development, specialised mooring hardware and/or instrumentation, provision of ship time, funding for operations, and support for training and capacity building.

7.3 Each partner may, at its discretion, contribute funds, personnel, and other resources to the Partnership subject to the laws, regulations, and policies of the Partner. Any costs arising from the activities contemplated in these terms of reference are to be borne by the Partner that incurs them, unless other arrangements are made.

8. **Intellectual Property**

All matters relating to intellectual property and the treatment thereof arising from cooperative activities of the Partnership are to be addressed on a case-by-case basis within the specific context in which they appear, bearing in mind the purposes of the Partnership.

9. **Amendments**

The Board may make recommendations to the ICG to amend this Terms of Reference at any time by consensus of the Partners on the Board.

10. **Commencement**

10.1 Cooperation under this Terms of Reference will commence on [insert date of agreement of the terms of reference]. The first meeting of the Working Group under these terms of reference will be in Melbourne in April 2006 to coincide with the 21st Assembly of the PTWS.

10.2 Any Partner may terminate its membership upon written notice to the Chair of the Board 90 days prior to the anticipated termination.

ICG/PTWS-XXI
INTER-SESSIONAL WORKING GROUP SUMMARY REPORT:
Working Group 3: Tsunami Hazard Identification and Characterization
3 May 2006

ICG/ITSU-XX Inter-sessional Working Group Three (WG3) met on May 2, 2006 morning at the Melbourne offices of the Australia Bureau of Meteorology to discuss tsunami hazard identification and characterisation issues and formulate recommendations for ICG/PTWS-XXI.

Attending:
François Schindele, France, Chair
Laura Kong, IOC-ITIC
Garry Rogers, Canada
Fujiang Yu, China
Tianyu Zhang, China
W T Wong, China
Ken Gledhill, New Zealand
Rob Bell, New Zealand
Jun Hee Lee, Republic of Korea
Yong Gyu Ryoo, Republic of Korea
Tatiana Ivelskaya, Russian Federation
Lev Rihzkov, Russian Federation
Dmitry Kamaev, Russian Federation
Ahmet Yalciner, Turquey
Ole Nielsen, Australia
Arthur Simanjuntak, Australia
Diana Greenslade, Australia
Spiro Spiliopoulos, Australia
Alexei Gorbatov, Australia

WG3 Terms of Reference

The WG3 charge, as stated in the ICG/ITSU-XX Summary Report, is:

- *To review and report on existing arrangements with regard to tsunami hazard identification and characterization.*
- *To advise on credible seismic scenarios that need to be captured for numerical tsunami modelling e.g., location, magnitude, rupture orientation, dip, and probability of occurrence.*
- *To review details on models that are currently used or in development.*
- *To review desirable documentation (inputs, outputs, etc.).*
- *To explore cooperation regarding coastal inundation models.*
- *To review as appropriate requirements for bathymetry.*
- *To develop guidance on mandatory metadata including detail of bathymetry, hydrography and topography*
- *To consider the issue of assessing hazard, vulnerability and risk, including the facilitation of access to models*

The Group reviewed each of the eight ICG/ITSU Terms of References. It was agreed to recommend that WG3 continue through the next inter-sessional period. A few issues were identified as high priority and sufficiently achievable to be recommended to ICG/PTWS-XXI for consideration as specific action items. These are:

To advise on credible seismic scenarios that need to be captured for numerical tsunami modelling e.g., location, magnitude, rupture orientation, dip, and probability of occurrence.

- List of historical earthquakes (major M > 8.5 and large M > 7.5)
- List of credible scenarios (major and large)
- List and reference of parameters necessary for the simulation
  (Rupture location, depth, width, length and dislocation, rigidity, focal parameters – strike, dip, rake-)
- Questionnaire will be provided by Chair WG3 to ITIC (Sept 2006)
- ITIC will send the Questionnaire to the Member States to provide information to ITIC (Dec 2006)

To review details on models that are currently used or in development

Numerical models are one of the important tools for understanding the generation and propagation characteristics of tsunamis, evaluating their coastal amplification and estimating their potential effects on the coastal areas. The history of numerical models for tsunamis started in 1980s. The first widely used model, TUNAMI N2 (which solves the nonlinear form of the long wave equations) was developed by Prof. Shuto and Prof. Imamura under the support of the UNESCO TIME Project in 1990s. Additionally, there are several other models (MOST, FUNWAVE, MIKE21, DELFT 3D, AVI NAMI, NAMI DANCE etc.) which allow the researchers and authorities to understand and evaluate several aspects of tsunamis such as generation mechanisms, propagation, coastal amplification and inundation. The recent models are capable of not only calculating numerical simulations, but also

capable of animation of the tsunami generation, propagation, and coastal impact for better visualization (i.e. AVI NAMI and NAMI DANCE).

- TIME , created by Dr Shuto (Japan) and implemented through ICG/PTWS programme (numerous training), included documentation
- TUNAMI-N2; documentation provided by Imamura and A. Yalciner
- MOST (Synolakis – Titov NOAA), FUNWAVE (Kirby USA), NAMI-DANCE (Yalciner),VOF, NTC, ANUGA, MIKE21 (Danish Hydraulics Institute), TUNA (Koh)
- Member States will provide information to ITIC on the Tsunami Modeling software name used in their country (Dec 2006)

To review desirable documentation (inputs, outputs, etc.). A list of Outcomes was identified, including:

- Hazard Maps showing areas of high potential for tsunami inundation.
- Inundation Maps (inundation and run-up) for maximum credible tsunami scenarios with recurrence interval or based on historical records, for areas of high vulnerability or risk.
- Risk Maps capturing the potential aggregated impact of all tsunami sources on the built environment, population and local and regional economy.
- Evacuation Maps, which include safe areas and shelters, how to get there, and where to go, based on scientific products.

Specific Issues related to Bathymetry and topography data were identified:

- To review as appropriate requirements for bathymetry.
- To develop guidance on mandatory metadata including detail of bathymetry, hydrography and topography. (X, Y, Z, reference datum, S-44 Standard, multi-beam, single-beam).
- To consider the issue of assessing hazard, vulnerability and risk, including the facilitation of access to models, GIS tools, multilayer , high resolution imagery, model outputs, loss and fragility models

While improving and making models more widely applicable, fundamental issues such as the effects of dispersion, friction, resolution requirements, and enhancement of accuracy by adaptive mesh refinement or nested modeling are necessary. All numerical models have certain error level depending on numerical scheme and mesh size etc. For better numerical results, the friction and diffusion terms can be used in the governing equations. The use of the dispersion term require longer computer processing time but provides more accurate wave amplitudes and wave forms in the shallower regions.

After having reviewed and discussed the relevant topic, WG3 made the following specific recommendations to ICG/PTWS-XXI:

1. Inter-sessional Working Group Three on Tsunami Hazard should continue through at least the next inter-sessional period. Greater participation from Member States is needed.

2. Member States will provide information to ITIC on the Tsunami Modeling software name used in their country, the related documentation, manuals and references. ITIC will collect this information and provide to IUGG/Tsunami Commission for review.

3. Member States will provide fulfilled questionnaires on credible seismic scenario (ITIC will transfer Questionnaire provided by Chair WG3).

4. Member States are requested to provide in their National report information on their Tsunami Hazard and Risk activities, in an annex.

ICG/PTWS-XXI
INTER-SESSIONAL WORKING GROUP SUMMARY REPORT:

Working Group 4: Resilience Building and Emergency Management
2 MAY 2006

ICG/ITSU-XX Inter-sessional Working Group 4 met on May 2, 2006 at the Melbourne offices of the Australian Bureau of Meteorology to discuss resilience building and emergency management and to formulate recommendations.

WG4 Terms of Reference

The WG4 charge, as stated in the ICG/ITSU-XX Summary Report, is:

To promote good practice examples of capacity and resilience building and emergency management to improve the management of tsunami risk through mitigation, preparedness, response and recovery activities. Such measures include the following:

- *Mitigation [Risk Reduction]: land use planning, building standards, engineering and non-structural counter-measures [, and hazard and risk assessments].*
- *Preparedness: capacity assessments, public education, training, response and evacuation planning and exercising.*
- *Response: effective forecasting and early warning systems coupled with sound communications systems.*
- *Recovery: infrastructure and socio-economic recovery plans supported by adequate financial and logistical resources.*
- *Public awareness.*

The meeting was scheduled to integrate into the Pacific Island Countries (PIC) Tsunami Workshop and was attended by 23 persons from 12 countries including 7 SOPAC Member Countries. A list of the attendees is attached as Appendix A. Due to Workshop commitments the SOPAC representatives were only able to attend the first and last parts of the meeting (presentations and final review/summary).

The meeting started with presentations on two topics representative of best practices:

1) Dominique Reymond, CEA/DASE/Laboratoire de Geophysique de Tahiti and Denis Musson, Head of Civil Defense, French Polynesia, **Consequences of two tsunami exercises in 2005, in French Polynesia: evolution of the tsunami warning**

This presentation identified the tsunami hazard in French Polynesia, presented information on two tsunami communication exercises carried out in 2005, and discussed improvements being made to the tsunami warning system as a result of these tests. The new communication system uses Inmarsat-C and a network of sirens on 60 islands. This network will be finished in 2008, but it will be tested on two islands during Exercise Pacific Wave 06.

2) Brian Yanagi, International Tsunami Information Centre, **TsunamiReady**

The *TsunamiReady* programme is designed to educate local emergency management officials and their constituents and to promote a well-designed tsunami emergency response plan for each community. *TsunamiReady* promotes tsunami hazard preparedness as an active collaboration among governments and local emergency management agencies. This collaboration supports greater and more consistent tsunami awareness and mitigation efforts among communities at risk. The *TsunamiReady* programme is intended to:

- Improve the timeliness and effectiveness of tsunami warnings for the public.
- Provide detailed and clear recommendations by which local emergency managers may establish/improve effective tsunami emergency operations.
- Help local emergency managers justify costs and purchases related to supporting their tsunami preparedness program.
- Increase public awareness and understanding of the tsunami hazard.
- Encourage consistency in educational materials and response among communities and states.
- Reward local tsunami hazard mitigation programs that have achieved a desired performance level.

- Provide an "image incentive" to coastal counties, cities, towns, and other designated communities, that can identify themselves as being *TsunamiReady*.

The Hyogo Declaration (2005) states that: "We are far from powerless to prepare for and mitigate the impact of disasters. We can and must alleviate the suffering from hazards by reducing the vulnerability of societies. We can and must further build the resilience of nations and communities to disasters through people-centreed early warning systems, risk assessments, education and other proactive, integrated, multi-hazard, and multi-sectoral approaches and activities in the context of the disaster reduction cycle, which consists of prevention, preparedness, and emergency response, as well as recovery and rehabilitation."

The Pacific Tsunami Warning and Mitigation System (ICG/PTWS) has been in existence for 40 years and in its Master Plan has the stated purpose "to provide or improve all aspects of tsunami mitigation in the Pacific including hazard assessment, warnings, preparedness, and research through a system of international cooperation and coordination of activities." In that context the promotion of best practices in emergency management and resilience building is consistent with both the group's stated purpose and the Hyogo Declaration.

This was the first meeting of the working group and much of the discussion centreed on identifying and discussing present best practices, or activities which are likely to support improvement.

Items discussed included:

1) Assessments – the IOC was an active participant in the *assessment of requirements and capacity for an effective and durable national tsunami warning and mitigation system* carried out with most Indian Ocean countries following the December 2004 tsunami. Some ICG/PTWS members have also completed this questionnaire, but a comprehensive set of assessments (all countries) is required to identify baselines and gaps in capabilities. As part of the up-coming PTWS exercise, Member States were requested to complete this questionnaire to support pre-exercise evaluation.

2) Signage – The ICG/PTWS established a working group several years ago to recommend a set of signs for international use. The approved signs (2) were submitted to the International Standards Association (ISO), but the approval process has not been satisfactory or conclusive. The ICG/PTWS needs to move ahead (if need be unilaterally) to promote one or more sign formats to other Tsunami Warning Systems.

3) Educational Materials – for many years the ITIC has been responsible for the development of a broad range of tsunami educational material. The new *Tsunami Teacher* will provide more information than ever before and this information will be directed to a broad range of client groups.

4) Information sharing – in addition to developing and publicizing educational material, TWS groups need to do a better job of sharing operational information (e.g. national emergency response manuals and hazard assessments) and linking to all-hazards and capacity building (resilience) information.

5) Communication methods – many WG attendees, particularly those from SOPAC, indicated that present communication methods do not meet the needs of small or isolated communities. An effective TWS must have communication systems that are reliable, and capable of providing a timely warning to communities. In support of that goal communication redundancy is an important consideration, as is a Communication Plan which is up-dated on a regular basis.

6) Following *Exercise Pacific Wave 06* it will be important for all Member States to complete the post exercise evaluation forms. These assessments will help us to identify and promote best practices.

7) Having identified a practice that supports improvement, there is a need to have a process for keeping this information up-to-date (i.e. continuous improvement.) It is also important to recognize that best practices may be regionally or culturally specific.

8) Promote high level advocacy that ensures a sustained commitment to prepare for infrequent, high fatality hazards such as tsunami and earthquakes (e.g. promote community initiatives such as *TsunamiReady* [TsunamiResilient].)

9) The PTWS needs to develop a structure for information "inter-operability" i.e. making the considerable amount of information that is not data (water level, seismic) or educational material available to all the Tsunami Warning Systems and their Member States. The WG envisions that this information would be available through the global portal.

10) The 36th Pacific Islands Leaders Forum (Madang, Oct 2005) endorsed for national implementation the regional disaster risk management framework "An Investment for Sustainable Development in the Pacific Island Countries Disaster Risk Reduction and Disaster Management, A Framework for Action 2005-2015 Building the Resilience of Nations and Communities to Disasters". PICs are committed to develop Strategic National Action Plans guided from the six themes of the Framework. These themes promote capacity building on an all-hazards approach, and in particular the enabling of communities to be well informed and motivated towards a culture of prevention and resilience. The WG and PTWS should look for opportunities to both support and learn from this initiative.

Further discussions within the Working Group noted that traditionally most of the expertise/representation in the PTWS has come from the seismic and sea level communities. To develop an effective and comprehensive (all-hazards) early warning system there is a need for greater Emergency Manager representation and more interaction with other agencies and groups (e.g. ISDR, WMO). In this context the objectives of WG4 require work in some areas outside the traditional core expertise of the PTWS.

The Working Group recommends that their work be continued through the up-coming inter-sessional period and that work focus on items (7) and (9) – the identification and maintenance of best practices, and improved information "inter-operability" through a web portal.

This work will be done by internet (e-mail) and, if approved, will involve the following countries/organizations and present contacts – Australia (Peter Willett), Canada (Chair – Fred Stephenson), New Zealand (David Coetzee), SOPAC (Attu Kaloumaira), Samoa (Filomena Nelson), USA (Brian Yanagi).

Appendix A

Attendees - Working Group Four meeting on May 2, 2006

Fred Stephenson	Canada (Chair)
Dale Dominey-Howes	Australia
Mark Sullivan	Australia
Geoff Cross	Australia
Helen Peerce	Australia
Denis Musson	France – French Polynesia
Dominique Reymond	France – French Polynesia
Ole Nielson	Australia
David Coetzee	New Zealand
Gordon Cheyne	Australia
Tyrone Deiye	Nauru
Andrew Kaierua	Naura
Moleni Tuuholoaki	Tonga
Alipate Waqaicelua	Fiji
Job Esau	Vanuatu
Johnson Binaru	Vanuatu
Eslin Garae	Vanuatu
Arona Ngari	Cook Islands
Attu Kaloumaira	SOPAC
Filomena Nelson	Samoa

Loti Yates	Solomon Islands
Peter Willett	Australia
Brian Yanagi	USA

ICG/PTWS-XXI
INTER-SESSIONAL WORKING GROUP SUMMARY REPORT:
Working Group 5: Interoperability and regional, sub-regional and national tsunami warning and mitigation systems in the Pacific
3 MAY 2006

ICG/ITSU-XX Inter-sessional Working Group Five (WG5) met on May 1, 2006 at the Melbourne offices of the Australia Bureau of Meteorology to discuss interoperability issues and formulate recommendations for ICG/PTWS-XXI.

Attending:
Charles McCreery, USA, Chair
Garry Rogers, Canada
Ken Gledhill, New Zealand
David Coetzee, New Zealand
Osamu Kamigaichi, Japan
Jun Hee Lee, Republic of Korea
Ryoo Yong Gyu, Republic of Korea
Tatiana Ivelskaya, Russian Federation
Lev Rihzkov, Russian Federation
Dmitry Kamaev, Russian Federation
Denis Musson, France
Dominique Reymond, France
Francois Schindele, France
Masahiro Yamamoto, IOC
Chris Ryan, Australia
Geoff Crane, Australia
William Erb, Australia
Spiro Spiliopoulos, Australia
Alexei Gorbatov, Australia

Comments on this report were also received from some attendees of ICG/PTWS-XXI including several delegates representing the Pacific Island Countries.

WG5 Terms of Reference

The WG5 charge, as stated in the ICG/ITSU-XX Summary Report, is:

To coordinate the development and operational implementation of warning systems in the Pacific, through

- *Advice on*
  - *the modalities of operation,*
  - *methods and standards for the development and issuance of warnings, and*
  - *requirements in terms of coordination and operating within a multi-hazard approach*
- *Advice on arrangements for redundancy and backup*
- *Support the update of the PTWS Communication Plan*

Motivation for Interoperability

WG5 identified key motivations for carrying out its work:

1) The global tsunami warning system that includes the PTWS is currently operating and will continue to operate with multiple warning centres (TWCs) having adjacent or overlapping areas of responsibility and simultaneous responsibilities for the same events. Information disseminated from multiple centres during events should be coordinated in form and content to avoid confusion or inaction that could in some circumstances result in the unnecessary loss of life.
2) Although each TWC may have unique responsibilities and challenges, they also have many similarities. They should work towards a common underlying concept of operations (CONOPS) that will allow them to more efficiently and effectively exchange data, methodologies, technologies, and procedures with each other as well as with their partners in a multi-hazard framework, and provide backup services for each other, thereby enhancing their reliability and sustainability.

A large number of general issues were identified as being related to interoperability. Most were not discussed in much detail nor specific recommendations made. It was agreed, however, to recommend that WG5 continue through the next inter-sessional period and probably through a longer period in order to work further on these issues. A few issues were identified as being of a high priority and sufficiently achievable to be recommended to ICG/PTWS-XXI for consideration as specific action items.

General Issues of Interoperability Identified

- Seismic, coastal and deep ocean sea level, and other critical data used by the TWCs to be open and freely shared in real time.
- Seismic, sea level, and other data needed by the TWCs be made available in common formats with up-to-date metadata. Seismic data formats are mature, but sea level data comes from providers in many somewhat ad-hoc formats.
- Requirements for seismic, sea level and bathymetric data for the different warning problems of local, regional, and tele-tsunamis be defined in terms of instrument coverage and spacing, sample rates, transmission intervals, frequency response, dynamic range, etc.
- STS-1 seismometers capable of measuring the very low frequency energy from great earthquakes, and necessary to accurately evaluate great earthquakes for their tsunamigenic potential, are no longer being produced.
- For consistency and efficiency, TWCs work towards using similar data sets, analysis methodologies, and implementations for doing the same problem – for example, for quickly detecting, locating and sizing distant earthquakes, or for determining tsunami travel times.
- Potential new data and methodologies applicable to the tsunami warning problem, such as from GPS, strong motion, undersea cables, hydroacoustic, radar altimetry measurements, and animal detection continue to be explored, evaluated, and implemented when appropriate. Such work be coordinated for all TWCs for efficiency.
- Critical methodologies used by the TWC's, numerical forecasting models for example, have a validation procedure.
- The IT of each TWC be structured in a way to enhance the exchange of methodologies and implementations. The use of open software, programming standards, and platform-independent programming languages is one example.
- Levels of tsunami alert, such as Advisory:Watch:Warning:Cancellations or No Tsunami:Small Tsunami:Large Tsunami or Green:Yellow:Orange:Red, be agreed upon and globally standardized.
- The criteria used to trigger each alert level (e.g., earthquake depth, magnitude, mechanism, distance from source, time to impact) be standardized.
- A standardized content and format for TWC products be established. Types of potential content are: state of alert, earthquake parameters, ETAs of first wave, first wave positive or negative, expected wave heights, expected inundation limits, ETA of maximum wave, duration of hazard, confidence limits, sea level gauge locations, sea level gauge data. Formats for both text and graphical products.
- Certain products in multiple languages be considered.

- What information should be disseminated from the regional TWCs to local emergency managers, to the media, and/or to the public, versus to the designated national focal points, during events?
- Product dissemination methods be standardized and simplified.
- Backup strategies between TWCs.
- Standardization of TWC documentation and its availability (internal and outreach).
- Portability of tsunami awareness and education materials and training.
- A hierarchy of authoritative tsunami information for each tsunami situation be established. National TWCs, for example, are likely to produce the quickest and most accurate earthquake hypocentre for an earthquake within their border.
- A decision-support database of historical data, tectonic data, and tsunami scenarios from numerical models be developed and distributed to all countries to aid in pre-event awareness and understanding of their tsunami threat, as well as for background information during events.

Specific Recommendations of WG5 to ICG/PTWS-XXI

1. Inter-sessional Working Group Five on Interoperability should continue through at least the next inter-sessional period. Greater participation from Pacific Island Countries is needed.
2. All TWCs should rapidly exchange their earthquake parameters, tsunami observations, and other operational tsunami information. A coordination tool should be developed to enable the (near) real-time internet exchange and display of this information.
3. Practice events such as the Pacific Wave Exercise on May 16-17, 2006, and other more regional or local exercises should continue to be carried out to maintain the level of readiness that will be required during a real event.
4. Areas of responsibility of each TWC should be identified, including the type of coverage provided (local, regional, or teletsunami). Areas in the vicinity of the Pacific without coverage for their threat (e.g., the Banda Sea for local and regional tsunamis) should be identified and existing TWCs should consider providing some type of coverage.
5. Work should continue to improve tsunami preparedness and warning coverage in the SW Pacific, including getting more countries to join the IOC-ICG/PTWS, advising them on setting up their national focal points and national TWCs, and developing an end-to-end tsunami warning capacity.
6. PTWS country assessments that were initiated prior to ICG/ITSU-XX should be completed and evaluated.
7. Regional TWCs should develop Short Message Service (SMS) abbreviated text messages for mobile telephones and SMS dissemination capabilities. Member States should provide SMS contact points.
8. Funding should be provided by the IOC or by Member States for WG5 to meet at least once during the Inter-sessional Period, as well as to facilitate carrying out any WG5 recommendations adopted by ICG-PTWS-XXI.
9. The PTWS Communication Plan should have its procedural information kept up-to-date by PTWC and focal point information kept up-to-date by the IOC (ITIC). The current Plan should be made available by the IOC over the internet and by hardcopy if requested. Focal point information should be kept secure by password or otherwise for distribution only to ICG/PTWS National Contacts and their designated focal points.

ANNEX IX

SUMMARY REPORT OF THE GLOBAL TSUNAMI DATABASE PROJECT

May 2006

Background

There are currently two global historic tsunami databases maintained separately by the World Data Center for Solid Earth Geophysics Boulder / NOAA's National Geophysical Data Center (WDC/NOAA) and the National Tsunami Laboratory (NTL/ICMMG) Novosibirsk. At the ITSU-XIX (2003) the International Tsunami Information Center (ITIC), WDC/NOAA, and NTL/ICMMG were tasked to implement a Global Tsunami Database (GTDB). The official copy of the database was to be housed and maintained at the WDC/NOAA where data could be accessed via web-based forms and ArcIMS interactive maps. The offline, stand-alone application (WinITDB graphic shell) would continue to be enhanced and maintained by (NTL/ICMMG).

At the ITSU-XX IOC/PTWS meeting in October 2005, the ITIC, WDC/NOAA, and NTL/ICMMG redefined the plan for reconciling these databases to focus on bringing the two databases into agreement with verification of the most significant tsunami events. A significant tsunami event was defined as causing $\geq$ 5 deaths or a maximum runup of $\geq$ 5 meters. Verification of the source event data includes data on the date, time, location, magnitude of the earthquake (if applicable), maximum event runup, and effects. The effects – including the total number of fatalities, injuries, houses destroyed, and damage – will be listed separately in the databases whenever possible for the source event and the tsunami. Verification of all data describing the runups associated with these events would not be done until the descriptions of the most deadly events are reconciled in the two databases. At the ITSU-XX (2005), the WDC/NOAA committed to the following activities for the future: (i) Continue Quality-Control of Databases focusing on Significant Events (all entries must have a reference); (ii) Implement New Java-Server Pages for QC Collaboration; and (iii) Tsunami-Travel Time Plug-in to Interactive Maps. In accordance with ICSU/WDC and NOAA policy, the WDC Global Historic Tsunami Database will continue to be in the public domain and free of copyright.

Report of the 2006 activity in the GTDB Project implementation

Significant Tsunami Events

Following this decision, WDC/NOAA prepared a list of "significant" tsunami events, based on data in both databases meeting the agreed criteria and provided the list to NTL/ICMMG (10/2005). The initial list contained 281 tsunami events. Since that time, WDC/NOAA and NTL/ICMMB have been working on the quality review of their respective databases. WDC/NOAA found a few duplicates in the list and the verification process removed some of the events for not meeting the criteria of a significant event (changes in either deaths or damage information). The list now contains 270 significant tsunami events.

Continue Quality-Control of Databases focusing on Significant Events

The WDC/NOAA historical tsunami database currently contains 1,488 valid events (not erroneous or meteorological) and 7,838 runup observations (not doubtful). The distribution of causes for these events is 86% earthquakes, 5% volcanoes, 3% landslides, 5% combination, and less than 1% unknown. WDC/NOAA's quality control efforts are focused in two areas: on Significant Tsunami Events and, as part of a U.S. tsunami hazard assessment project, on events that caused fatalities in the United States, territories, and commonwealths. As a result of these efforts, WDC/NOAA has now verified 50% of the significant tsunami events. WDC/NOAA expects to complete review of the Significant Tsunami Events in calendar year 2006. These data are available on the WDC/NOAA website via forms-based interfaces and interactive maps (Figure 1).

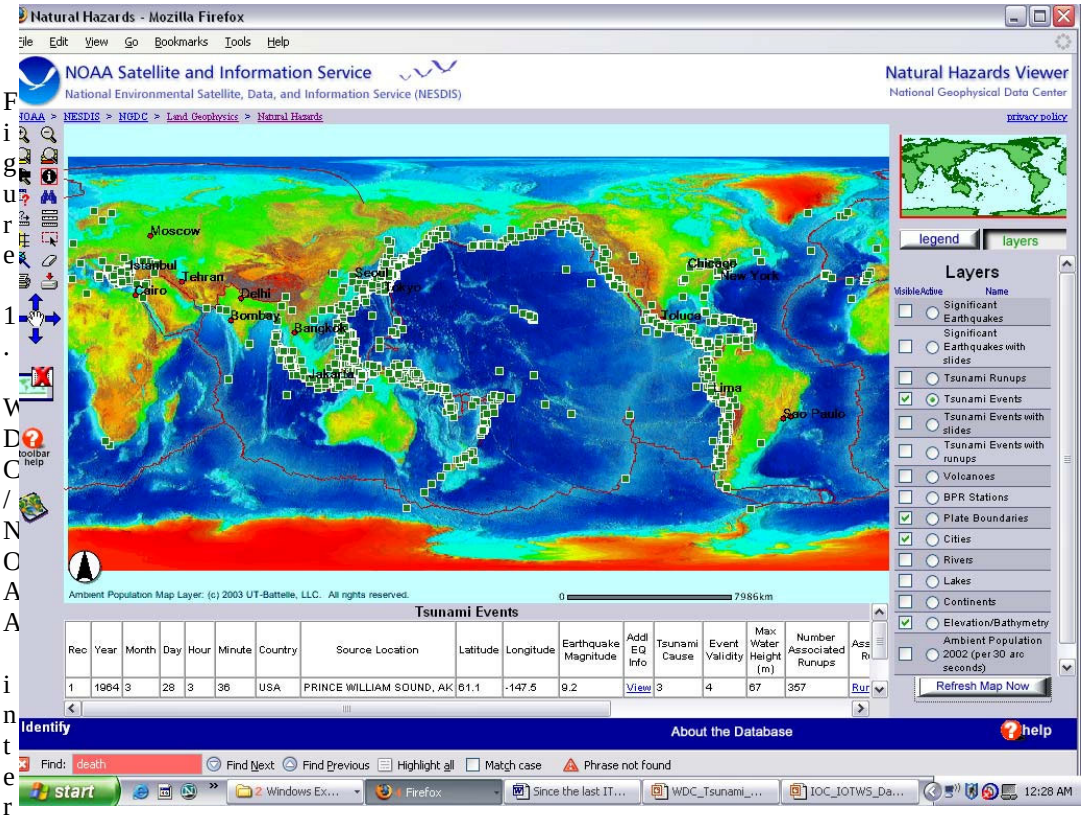


Figure 1. WDC/NOAA interactive maps provide access to the tsunami, significant earthquake, and volcano databases. http://www.ngdc.noaa.gov/seg/hazard/

During the quality assurance process, WDC/NOAA often finds differing reports in the original sources for the tsunami source location, date, earthquake magnitude, total effects, etc. WDC/NOAA's method for indicating this uncertainty is to collect all the sources that describe an event, review and then choose the best description of the data for each part of the event record (e.g. source location, date, earthquake magnitude, maximum event runup, effects), update the event record with the best information, and identify the differing reports and sources. Each event record also has a *Comments* section where, among other information, all of the source reports are listed in a table containing the conflicting data (i.e. source location, earthquake magnitude, etc.) and source of the data. Ultimately, the user can decide if he/she agrees with WDC/NOAA's choices and review the original sources (Figure 2).

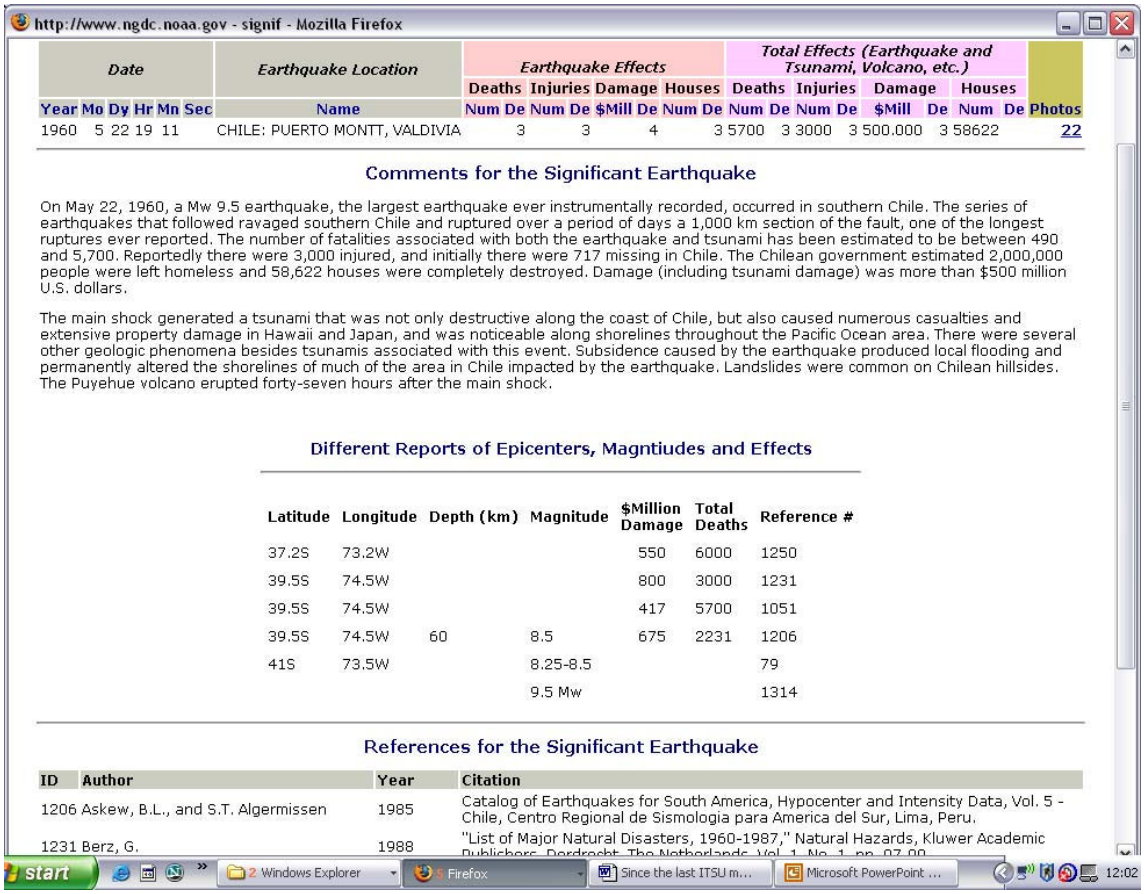
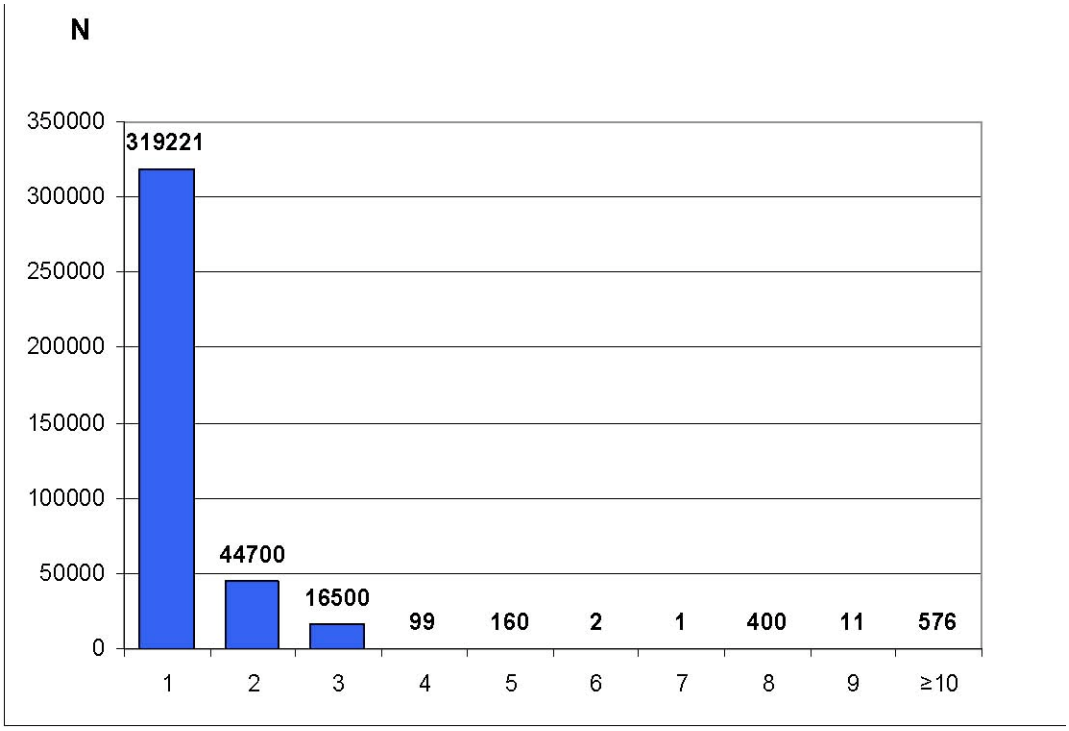


Figure 2. Example of Comments section for an event in the WDC/NOAA database.

Report of the NTL/ICMMG 2006 activity in the GTDB Project implementation

In 2006 under the GTDB Project implementation, the main efforts of the Novosibirsk Tsunami Laboratory (NTL/ICMMG) were focused on further updating and data verification for 11 of the largest historically known events (trans-oceanic tsunamis) responsible for great material damage and most of the fatalities. For these events, the list of observed run-up heights was extended by adding additional data available in recently published catalogs and original publications. In total, these 11 events have 2930 run-up values provided with geographical coordinates of observational sites that is almost 30% of all run-up entries currently available in the NTL/ICMMG database. Special attention was given to collection and verification of the data on spatial distribution of fatalities resulted from these tsunamis. These fatalities were analyzed in terms of their distribution over the tsunami travel time (TTT) intervals. Results are shown in Figure 4, which clearly indicates that almost 84% of all fatalities occur within just one hour after the event occurrence. Another 12% of fatalities happen within second hour of TTT, and the rest of 4% occur during the remaining time (greater than 2 hours). It should be stressed that this analysis involves the largest historically known tsunamis (trans-oceanic) capable to propagate thousands kilometers away of the source area. The overwhelming majority of other tsunamis (that is 99.5% of all historical cases and 95% of all damaging events) are the local and regional events whose major damage and all fatalities are limited to near-source area within 20-40 min of travel time. This is a fundamental fact that should be taken into account in design and implementation of any regional or basin-wide tsunami warning system.



t
alities depending on tsunami travel time (TTT) in hours. The digits above columns show accumulated number of fatalities occurred within particular interval of TTT for 11 trans-oceanic tsunamis listed in Table 1 (following).

In response to the recommendation of the IUGG Tsunami Commission business meeting (Hania, Greece, July 2005) NTL/ICMMG undertook additional efforts for summarizing measurements collected in the field surveys of the 2004 Sumatra tsunami and their input into the RUN-UP data file of the database. Currently, this file contains 577 run-up entries for the December 26, 2004 Sumatra tsunami measured along the coast of 11 countries in the Indian Ocean region, that is the largest set of run-up measurements for a single tsunamigenic event in the database.

Comparison of NTL/ICMMG and WDC/NOAA data for selected events

A comparison of event data for the 11 events described in the previous section in the NTL/ICMMG and WDC/NOAA databases is listed in Table 1. There are many differences in the magnitudes and maximum runups, as well as major differences in the number of fatalities reported. WDC/NOAA and NTL/ICMMG will now begin comparing the original source materials to resolve the differences in these events.

Table 1. List of historically known transoceanic tsunamis from the NTL/ICMMG and WDC/NOAA databases.

Date and place	Mag. (NTL)	Mag. (WDC)	Max run-up NTL	Max run-up (WDC)	Fatalities (NTL)	Fatalities (WDC)
November 1, 1755 Lisbon	8.5		18	12.2	40000	60000[1]
November 7, 1837 Chile	8.5	8.5	8	6.0	many	16
August 13, 1868 Chile	9.1	8.5	18	21	3000	25000[1]
August 27, 1883 Krakatau			36	35	36417	36500[2]
February 3, 1923 Kamchatka	8.3	8.3	8	8	some	some
April 1, 1946 Aleutians	7.4	7.3	42	35	165	165
November 4, 1952 Kamchatka	9.0	9.0	18	18	10000	none
March 9, 1957 Aleutians	9.1	9.1	15	15	none	none
May 22, 1960 Chile	9.5	9.5	18	25	1180	1260[3]
March 28, 1964, Alaska	9.2	9.2	68	67	123	121
December 26, 2005 Sumatra	9.3	9.0	34	34.9	280000	297248

[1] Deaths due to earthquake and tsunami.
[2] 2,000 deaths due to volcanic eruption.
[3] Additional 15 deaths due to the earthquake.

WDC/NOAA Implement New Java-Server Pages for QC

WDC/NOAA continues to expand its password-protected web-collaboration tools. The tsunami, significant earthquake, significant volcanic eruptions, and reference citations are all stored in an Oracle database (Figure 5). Using these tools, scientific collaborators agreeing to the strict guidelines for event verification and entry, are now working remotely with WDC/NOAA to improve the quality and content of the databases. Scientists can add, update, or delete records from anywhere in the world. To facilitate collaboration, the database was expanded to track the date of the last change to a record and track which part of the record has been updated (e.g. source date, time, location, magnitude, maximum runup, and effects). WDC/NOAA built additional search interfaces to improve utility. For example, a user can now search for all of the references related to one or more tsunami events or search for all of the tsunami events related to a particular reference. Paula Dunbar of the WDC/NOAA worked with Dr. Lori Dengler (Humboldt State University, California) to provide training on the use of the tools. Dr. Dengler and her graduate students now regularly and extensively use these tools. Dr. Dale Dominey-Howes, Macquarie University, Sydney, Australia, visited WDC/NOAA in January 2006 and also plans to begin using the web-collaboration tools. WDC/NOAA retains overall control of the content.

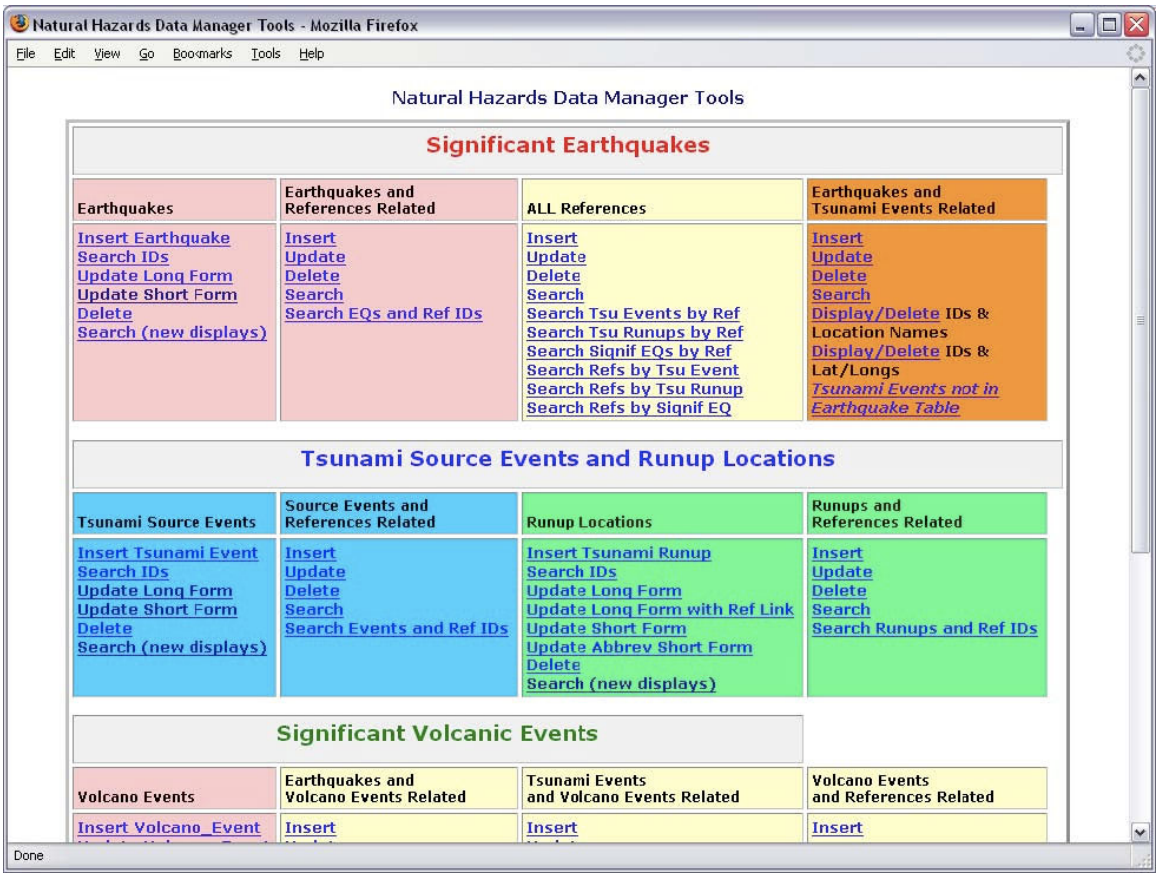


Figure 5. WDC/NOAA Natural Hazards password-protected web-collaboration tools.

WDC/NOAA Tsunami-Travel Time Plug-in to Interactive Maps

In 2005, ITIC and WDC/NOAA obtained a license to provide the Tsunami Travel Time (TTT) software, developed by Paul Wessel (University of Hawaii) and in use by the Pacific Tsunami Warning Center, as a stand-alone CD-ROM product and as a plug-in to the WDC/NOAA online interactive hazard maps. To test the results of the software when different bathymetric grid resolutions are used, WDC/NOAA produced tsunami-travel-time maps for major teletsunamis in the Atlantic, Indian and Pacific Oceans and compared the modeled travel time results to travel times for runups associated with actual events. Travel time maps now accessible from WDC/NOAA's website (Figure 6). Each map is linked to search results for the event in the digital historical tsunami database. Prior to posting the model results, WDC/NOAA verified the data for these source events and the travel times for the associated runups. During the summer of 2006, WDC/NOAA will implement the interactive Web Tsunami Travel Time Tool, which will be linked from the Natural Hazards interactive Web maps (http://www.ngdc.noaa.gov/seg/hazard/)

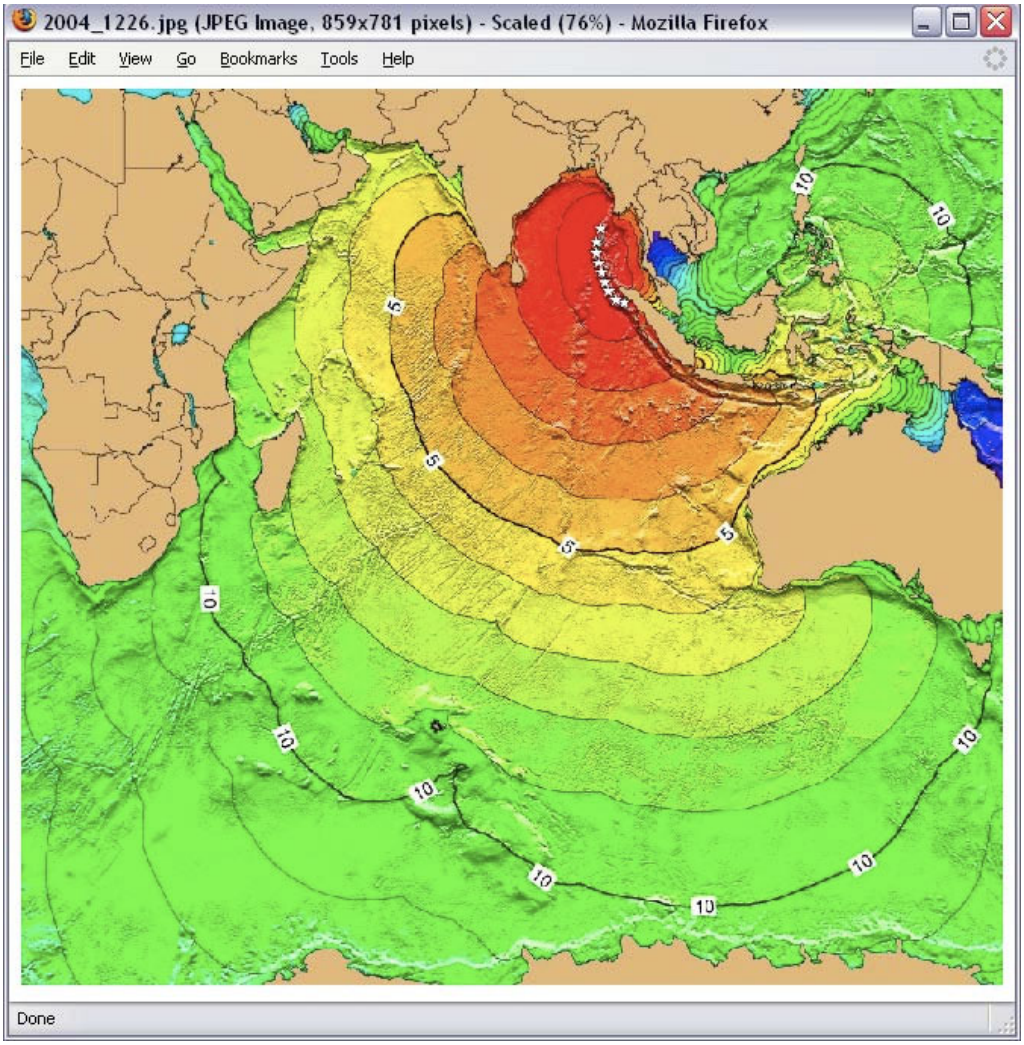


Figure 6. Tsunami-Travel-Time map for the 2004 Indian Ocean Tsunami available on the WDC/NOAA website.

Future Plans

WDC/NOAA and NTL/ICMMG will continue verification of the most deadly tsunami events and comparison of source materials. WDC/NOAA is also compiling a database of significant volcanic eruptions that includes similar event effect information (deaths, damage, injury, etc.) linking also to the tsunami and earthquake databases if there was a related event.

WDC Visiting Scientists Program

WDC/NOAA has an active program providing support for scientists to visit the WDC and work on specific issues of mutual interest. In the last year, scientists from Denmark, Britian, Germany, and Australia visited to collaborate on SEG projects. Proposed visits for this year related to tsunami activities include Dr. Dale Dominey-Howes, Macquarie University, Sydney, Australia and Dr. Gaye Downes New Zealand Geosciences. Interested scientists should contact Susan McLean (Susan.McLean@noaa.gov) or Paula Dunbar (Paula.Dunbar@noaa.gov).

ANNEX X

SOPAC Summary Report ~ Sept 2005 – 2006
to the ICG/PTWS XXI Meeting, Melbourne 3-5 May 2006

1. INTRODUCTION

1-1 Management of Tsunami Risks – SOPAC region

SOPAC, which is mandated to coordinate disaster risk management activities in the region, is promoting at the national level an integrated comprehensive approach to the mainstreaming of disaster risk management within the ambit of the regional framework "*An Investment for Sustainable Development in the Pacific Island Countries, Disaster Risk Reduction and Disaster Management, A Framework For Action 2005 – 2015: Building The Resilience Of Nations And Communities To Disaster"*. The Framework is aligned with the Pacific Plan approved by the regional Leaders and Heads of governments. The process of risk management in the context of national development planning. is documented as a Regional Guideline on Comprehensive Hazard and Risk Management (CHARM). SOPAC works in partnership with the National Disaster Management Offices (NDMOs) who in turn manage the national-level disaster risk management arrangements. On tsunami hazards and relevant warning systems, the NDMOs work together with their respective national Meteorological Services and Seismology/Geology Units within national geological surveys (for those states that have one).

Tsunami is but one of the many natural hazards posing great threat to the Pacific Island Countries (PICs), which are very vulnerable due to their geographic and geological settings, coastal concentration of populations and to the low technical and management capacity to address tsunami risks particularly in terms of early warning, response and preparedness. In the last decade there were two significant events with the Aitape tsunami (1998 Papua New Guinea) being a major disaster with thousands of lives lost and that of Merle Bay, Pente-cost Island (1999 Vanuatu) a localised event that devastated a village.

1- 2 Early Warning Systems

SOPAC favours and is a strong advocate of an integrated all hazards approach to Early warning systems (EWS) wanting these to be effective and people-focussed, and providing greater clarity in the warning and its related information so as to more effectively reduce risks at both national and local levels. Warnings of threatening events need to be complemented by information on the risks posed by the hazard and the likely strategies for mitigating the loss and damage that could arise. This "value added" warning information then needs to be communicated to vulnerable groups and sectors in a way that facilitates good decisions and timely actions.[2] PICs need systems capable of providing effective two-way communication over vast ocean distances both within and between countries, and particularly to reach small isolated populations on small islands within a vast ocean. In today's setting, it is essential that these systems interact with developing global network of observing systems so as to provide access to technical resources and information much lacking in PICs. At the same time they need to be tailored to remain community-focussed (e.g.; simple, easily understood and actionable).

2. SOPAC Activities related to Tsunamis (October 2005 – 2006)

SOPAC appreciates the opportunity to report at this ICG/PTWS XXI Meeting on its current initiatives and activities that relate to building tsunami awareness and mitigation capacity of its

[2] Baseline survey of Hazard Warning and Disaster Response Systems for Pacific Island States – *SOPAC Report to the Commonwealth Secretariat,* June 2005

member countries. It is both ready and willing to work in partnership with agencies in the region to support and further progress these and related initiatives.

2-1 SOPAC Community Risk Programme (SOPAC – CRP)

The thrust from the SOPAC Community Risk Programme in this reporting period is to establish a partnership approach in the development of all hazards early warning systems. And in this it has established a network of key stakeholders supporting the EWS partnership approach.

2-1(a) Planning Meeting, Sept 2005: *"A Draft Strategy for Enhancing Early Warning for Pacific Island Countries"*[3]

Following the Mauritius International Meeting on Small Island Developing States and the Second World Disaster Conference in Kobe, January 2005, the Pacific region developed its disaster risk reduction and disaster management framework *"An Investment for Sustainable Development in the Pacific Island Countries, Disaster Risk Reduction and Disaster Management, A Framework For Action 2005 – 2015: Building The Resilience Of Nations And Communities To Disaster"*.

This Framework was later adopted by the Pacific Island Forum Leaders as a key initiative related to implementation of the Pacific Plan at the Thirty-Sixth Pacific Islands Forum 25 –27 October 2005 in Madang, PNG.

The Framework comprises six themes, one of which is addressing Effective, Integrated and People-Focused Early Warning Systems and it emphasises that early warning systems need to be based on:

- Prior knowledge of the specific hazards and risks faced by the communities,
- Sound scientific and technical monitoring and sustainable warning services for these hazards and risks,
- Dissemination of timely and understandable warnings, and
- Local knowledge and preparedness to act.

The expected outcomes by 2015 are:

- Robust, effective national and regional monitoring and early warning systems established and strengthened for all hazards incorporating traditional knowledge and appropriate technology and tools.
- Community, national and regional warning systems integrated into the global network supporting early warning and vice-versa to improve safety and security to disasters
- Effective communication and awareness raising in place as part of these community-focused early warning systems

SOPAC-CRP convened a Planning Meeting of relevant key stakeholders within the region to develop strategies describing actions to be implemented in order to achieve the outcomes of this theme. A *Draft Strategy for Enhancing Early Warning for Pacific Island Countries* was produced and later finalised after deliberations at the 34th SOPAC Governing Council, 19 – 23 September 2005 in Apia, Samoa.

The Strategy expanded on the following key national activities prioritised in the Framework for the early warning theme.

[3] PS0034 Proceedings of the Thirty-fourth Session [hosted by the Government of Samoa at the Hotel Kitano Tusitala, Apia, Samoa] 24-30 September 2005.

Establish and/or strengthen institutional capacities to ensure early warning systems are integrated into governmental policies, decision-making processes and emergency management systems at both national and community levels.

A range of key activities to facilitate strengthening of institutional capacity was identified in the strategy. Of significance amongst these were risk assessment, the enabling of key agencies to execute early warning responsibilities, the use of risk mapping in development planning, the strengthening of communication systems between agencies as well as from national level to the remotest communities, and encouraging PICs to gain membership of IOC.

Complete inventories and needs analyses of national early warning systems ensuring inputs from all stakeholders, including traditional knowledge and community needs.

Upgrade or redesign existing national forecasting or early warning systems to cater for major hazards.

With respect to tsunamis, the strategy aims to encourage that all PICs receive the Pacific Tsunami Warning Center (PTWC) bulletins, that they have capability to interpret these bulletins and that they are prepared to respond on a 24/7 basis.

Develop and implement a comprehensive programme for community awareness and preparedness.

The strategy favours an all hazard approach and targets to develop hazard-aware communities through education and awareness raising so that they become 'front line' observers of precursory signs of impending threats (eg volcanic eruptions, tsunami events, floods and other hazards).

2-1(b) North Pacific Sub Regional "Tsunami Ready" Workshop, Guam 13-15 June 2006

The initiative is a joint partnership between NOAA, SOPAC and ITIC aimed to bring together National Weather Services staff and emergency managers of the US affiliated Pacific island states and territories in the North Pacific.

The workshop is aimed at raising awareness of tsunami risks, existing early warning and response systems for the North Pacific region and to describe various ways that tsunami hazards are detected and assessed.

2-1(c) SOPAC "South Pacific Tsunami Awareness Kit"

PDC was commissioned to undertake the development of a Tsunami Awareness Kit adapting work carried out in other regions and work was completed late 2005. The Kit has a lot of awareness material that are generic and ready for use in any PIC countries. It also has materials requiring local adaptation in the country of usage eg tsunami maps. The Kit is provided with a DVD disc to allow countries to adapt as is needed. Technical people from Papua New Guinea, Vanuatu and Fiji assisted PDC in sourcing the material.

As most of the country level material is from Fiji, SOPAC-CRP has started work planning discussions with Fiji on how best to disseminate the Kit. It will involve a workshop to present the Kit, define agreed first targets and to develop appropriate approaches to reach these targets.

2-1(d) International Training Workshop on Numerical Modeling of Tsunami For Developing Countries in Southeast Asia, the Pacific, and the Indian Ocean, 07-19 November 2005: PHIVOLCS, Quezon City, Philippines

SOPAC-CRP sought and secured a fellowship from the SOPAC/EU Project that enabled Mr Lawrence Anton, PNG to attend this training in tsunami modelling. The acquired skills will support the SOPAC/EU Project Papua New Guinea Work Plan on tsunami assessment.

The SOPAC/EU Project's intervention area in North West PNG has a history of significant tsunami events. This Fellowship has provided further local capacity, along with the fieldwork by the University of Papua New Guinea also being funded by the Project, to contribute to the assessment on tsunami hazard of the North West coast from Vanimo to the Indonesian Border.
2-1(e) Participation in Pacific Tsunami Workshop 1-2 May 2006 Melbourne

SOPAC provided regional perspectives and preliminary data on national capacities to assist provide a broad base picture of national capabilities in the region towards a proposed project for a more comprehensive assessment on national capacities of PICs
2-1 (f) ICG/Pacific Tsunami Warning and Mitigation System: Working Group on Resilience Building and Emergency Management.

The inaugural meeting was held on 2 May in Melbourne with SOPAC nominated into the Working Group to represent the SOPAC region.

2-2 SOPAC Ocean and Island Programme (SOPAC-O&IP)

2-2(a) South Pacific Sea Level and Climate Monitoring Project (SPSLCM)

Phase III of this AusAID funded initiative to assess long term variability in sea level within the Pacific was completed at the end of 2005. Phase IV covering a further 5 years (2006-2011) commences from 2006. SOPAC's primary role within the project has been related to technical support in station maintenance and survey activities which are undertaken.

SOPAC-O&IP seeks to integrate Project findings into disaster risk management planning and welcomes cross-fertilization through experiences and current initiatives that others can share.

2-2(b) Pacific Island – Global Ocean Observing System (PIGOOS)

The PI-GOOS Secretariat is housed at SOPAC and managed by the PI-GOOS Coordinator. It still very much retains the primary focus to work within an integrated framework that systemically acquires oceanographic and marine data, and disseminates this as useful information in response to the needs of government, scientific research and the public, to address marine related issues.

Established in 1998, PI-GOOS, in relation to this meeting, is now embarking to strengthen integration of its findings into disaster mitigation activities inclusive of tsunami hazards. A recent activity is its web-portal that is currently under construction but designed to include researched "good tsunami mitigation practices" from around the world, e.g. mangrove tsunami-abating characteristics.

3.0 Forward Looking

SOPAC, which is now a designated Center of Expertise on the all hazards approach, recognizes that efforts to date are primarily and essentially the framing of what needs doing and of strategising the work plan to cover the SOPAC region.

In moving forward, a lot of work, good will and partnership is still needed to at least implement activities prioritized to date. In an effort to bring together greater collaboration in the implementing of the Framework, a Partnership Network Initiative now exists and coordinated by SOPAC-CRP. It is a partnership of agencies that have a stake in the mainstreaming of risk management into national development planning processes.

The first major target is to avail Partnership support to each SOPAC member country in the development of their respective Strategic National Action Plans (SNAP) 2005-2015. And consequentially support as relevant in SNAP implementation.

SOPAC invites agencies in the meeting to consider joining the Partnership Network Initiative in support of a collaborative approach at both the regional and national level.

Atu Kaloumaira
Risk Advisor – Community Risk Programme

ANNEX A: EARLY WARNING SYSTEMS AND CAPABILITIES4 (June 2005)

Country	Hazards	External Agency Providing Early Warning	National Agency Responsible For Early Warning	Status of Early Warning System	Limitations	Needs
Cook Islands	Tropical Cyclones	Nadi Regional Specialized Meteorological Centre (RSMC)	Cook. Is (CI) Met Service	National coverage	Poor post- event communications may limit follow-up warnings	More robust communications systems
	Flooding		C.I. Met Service and Works Dept Hydrology Unit.	Limited to inclusion in weather forecasts	No flood monitoring capability	
	Storm Surge	Nadi RSMC	C.I. Met Services	Limited to inclusion in weather forecasts	No detailed warning	See Fiji
	Heavy Rain		C. I. Met Services	Limited to inclusion in weather forecasts		
	Tsunami	Pacific Tsunami Warning Centre (PTWC)	C.I. Met Services and National Disaster Management Office (NDMO)	National coverage	No local tsunami warning capability	
	Landslides		Unclear	None	No warning capability	
	Waterspouts and tornados		C.I. Met Services.	Limited to inclusion in weather forecasts		
Fiji	Cyclone	Nadi RSMC	Fiji Met Service	National coverage. Staff shortage, storm surge warning needed	Warnings give detailed cover of wind speed but little information on storm surge	Development of RSMC storm surge forecasting capability.
	Flood		Fiji Hydrology Unit.	Partial system exists - Fiji Hydrology Unit has piloted a telemetry system in one sub-catchment only of the Rewa River	Other major rivers are not covered	Resources and training for further development of community-based systems

[4] Baseline survey of Hazard Warning and Disaster Response Systems for Pacific Island States – *SOPAC Report to the Commonwealth Secretariat*, June 2005

Country	Hazards	External Agency Providing Early Warning	National Agency Responsible For Early Warning	Status of Early Warning System	Limitations	Needs
	Tsunami	PTWC	Fiji Met Services and Seismology Unit	(a) PTWC warning messages received by Fiji Met Services and passed to Seismology Unit of the Mineral Resources Dept. (b) Cabinet has recently approved establishment of a local Tsunami Early Warning System.	Public are still not fully aware of the warning system	Improved public awareness and education
	Drought	NIWA	Fiji Met Services	Drought Warnings issued based on below average rainfall and external information.	Link between ENSO events and drought in Pacific countries is poorly understood	Further international research
	Landslide		Dept of Geology and Mineral Resources	Work started on a pilot landslide early warning project a few years ago but project ended after the consultant left.	Projects never tested and proved	Further support with development of a system
French Polynesia	Cyclones	Meteo France/Tahiti	Meteo France Tahiti			
	Tsunami	PTWC	CPPT (CEA/LDG-Tahiti) and Protection Civile			
Federated States of Micronesia (FSM)	Cyclones (Typhoons)	Joint Typhoon Warning Centre (JTWC) - Guam	National Weather Service	Incomplete broadcast coverage	Communications to some distant States are limited	Improved communications and broadcast capabilities
	Tsunami	PTWC to local met service	NDMO	Incomplete broadcast coverage	Communications to some distant States are limited	
	Drought	PEAC PDC	National Weather Service	Incomplete broadcast coverage	Drought Warnings issued based on below average rainfall. Link between ENSO events and drought	Further international research

Country	Hazards	External Agency Providing Early Warning	National Agency Responsible For Early Warning	Status of Early Warning System	Limitations	Needs
					in Pacific countries is poorly understood	
	Floods		National Weather Service	Flash flood warnings based on rainfall		
Kiribati	Cyclones	Nadi RSMC	Kiribati Weather Service	Extremely low risk		
	Tsunami	PTWC	NDMO			
	Drought	PEAC, NIWA	Fiji Met Services	Drought Warnings issued based on below average rainfall and external information.	Link between ENSO events and drought in Pacific countries is poorly understood	Further international research
Marshall Islands	Cyclones (Typhoons)	JTWC - Guam	Marshall Islands Met Service	Incomplete broadcast coverage		
	Tsunami	PTWC to local met service	NDMO			
	Drought	PEAC	Marshall Islands Met Services	Drought Warnings issued based on below average rainfall.	Link between ENSO events and drought in Pacific countries is poorly understood	Further international research
Nauru	Cyclones	Nadi RSMC	Nauru Met Service	Extremely low risk		
	Tsunami	PTWC	Not Known			
	Drought	NIWA	Nauru Met Service	Drought Warnings issued based on below average rainfall and external information.	Link between ENSO events and drought in Pacific countries is poorly understood	Further international research
New Caledonia	Cyclones	Meteo France/Noumea	Meteo France, Noumea			
	Tsunami	PTWC	Meteo France and Protection Civile			
Niue	Cyclones	Nadi RSMC	Niue Met Service	National coverage although some delays to	Met Service only has Observers – no local	Upgrading of regional warning to include storm surge and wave/swell

Country	Hazards	External Agency Providing Early Warning	National Agency Responsible For Early Warning	Status of Early Warning System	Limitations	Needs
				communications shielded areas.	forecasters	information
	Tsunami		Police	National coverage although some delays to communications shielded areas.	No direct tsunami warnings	Access to tsunami messages
Palau	Cyclones (Typhoons)	JTWC - Guam	Palau Weather Service	Incomplete broadcast coverage		
	Tsunami	PTWC	Palau Weather Service & NDMO	Incomplete broadcast coverage		
Papua New Guinea	Cyclones	Brisbane TCWC	PNG National Weather Service (NWS)	Coverage in affected provinces is adequate	Limited forecasting capability	Met. Training, Public awareness, communication systems
	Tsunami	PTWC	Geophysical Observatory and NDMO	Coverage in affected provinces is adequate		
	Volcano		National Volcano Observatory and Provincial Governments	Only covers volcanoes that pose major threats	Only occasional monitoring of minor but active volcanoes	Support for wider monitoring networks and staff
	Floods		PNG NWS	General warnings provided in weather forecasts	No flood monitoring capability even on major rivers	Development of a flood monitoring capability
	Drought	NIWA, BOM Australia, WMO	PNG NWS and Dept of Agriculture	Warnings transferred through media releases and by agricultural extension officers	Link between ENSO events and drought in Pacific countries is poorly understood	Further international research
	Frost		PNG NWS	Coverage in high provinces through radio broadcasts	Frost mainly occurs on clear nights destroying staple crops. Cloud cover observations	Improved observation network
Samoa	Cyclones	Nadi RSMC	Samoa Met	National coverage		

Country	Hazards	External Agency Providing Early Warning	National Agency Responsible For Early Warning	Status of Early Warning System	Limitations	Needs
		American Samoa Weather Service	Service			
	Earthquakes		Ministry of Agriculture (Observatory)	Monitoring through a few seismometers	Restricted coverage	Better instrumentation
	Tsunamis	PTWC	NDMO	National coverage		
	Volcano		Ministry of Agriculture	Limited by equipment	Detection of movement through seismometers and occasional visits	Telemetered observation network
	Flood		Samoa Meteorological Service	National coverage	No flood monitoring systems exist so warnings based on forecast rainfall	
Solomon Islands	Cyclones	Brisbane TCWC	.Solomon Islands met service	Incomplete broadcast coverage HF SSB radio also used to villages	Broadcasts cannot be received in remote areas at all hours.	
	Tsunami	PTWC	Local met service and NDMO	Both contact points through EMWIN are not 24 hour so alerts can be delayed	No 24 hour contact point for watch and warning messages	New 24 hour contact.
	Volcano		Ministry of Mines and Energy and NDMO	Monitoring via seismometers and satellite	No 24 hour coverage. Limited staff resources	More trained staff and upgrading of equipment
	Drought	NIWA	Min of Agriculture and Livestock	Undeveloped	Link between ENSO events and drought in Pacific countries is poorly understood	Further international research. Need to translate ENSO reports into understandable language
Tokelau	Cyclones	Nadi RSMC Samoa Met service	Tokelau Weather Service	Very limited. Broadcasts from Samoa	No Met service. No broadcasting station. Three atolls in country – several hours apart by sea. Vulnerable comms	Development of national warning system
	Tsunami	PTWC				

Country	Hazards	External Agency Providing Early Warning	National Agency Responsible For Early Warning	Status of Early Warning System	Limitations	Needs
	Drought	NIWA	Tokelau Weather Service and Agriculture Department		Link between ENSO events and drought in Pacific countries is poorly understood	Further international research
Tonga	Tropical Cyclone	Nadi RSMC	Tonga Met Office	National coverage	Warnings from Fiji cease when the national satellite dishes are locked in high winds.	
	Earthquake		Ministry of Lands and Survey	Newly installed seismic network monitors and locates earthquakes	Network is still very new.	
	Tsunami	PTWC	Tonga Met Office	National coverage	Local earthquake monitoring cannot forecast local tsunamis	
	Drought	NIWA	Tonga Met Office	National coverage	Link between ENSO events and drought in Pacific countries is poorly understood	Earlier warning. Further international research
	Storm Surges	Nadi RSMC	Tonga Met Service	National coverage	Warnings are too generalised to be practically useful	Better storm surge forecasting
	Coastal Flooding		Tonga Met Office	Covered in local weather forecasts		
	Volcano		Ministry of Lands and Survey	Seismic monitoring of the volcano area	Accurate Eruption warning is not possible at present	Improved monitoring and training for technical staff.
Tuvalu	Cyclones	Nadi RSMC	Tuvalu Meteorological Service	Incomplete broadcast coverage due to technical problems	Storm surge forecasting is inadequate for an atoll country	Better storm surge forecasting from Nadi Improved communications
	Tsunami		Met Service			
	Drought	NIWA	Tuvalu Meteorological Office		Link between ENSO events and drought in Pacific countries is poorly	Further international research

Country	Hazards	External Agency Providing Early Warning	National Agency Responsible For Early Warning	Status of Early Warning System	Limitations	Needs
					understood	
Vanuatu	Cyclone	Nadi RSMC	Met Service Vanuatu	Incomplete broadcast coverage due to distance	Distance	Storm surge
	Tsunami	PTWC	NDMO			
	Drought	NIWA	Met Service Vanuatu		Link between ENSO events and drought in Pacific countries is poorly understood	Further international research
	Volcano		Department of Geology	Monitoring provides some advanced warning but coverage incomplete	Limited and ageing French equipment. Communications	Upgrading of equipment
	Earthquake		Department of Geology	Monitoring rather than warning	Limited and ageing French equipment. Communications	

ANNEX B; NATIONAL DISASTER RESPONSE CAPABILITIES AND NEEDS

Country	Plans, policies, legislation, structure	Key response partners	Emergency operations centre(s)	Human resources training[5]	Community preparedness	Emergency comms	Emergency stockpiles	Needs
Cook Islands	Yes but need review	Red Cross	National Emergency Operations Centre (NEOC)	50+ 250 but still not meeting the needs	Satisfactory	Full national coverage	2 DPC[6]	Human Resource training and backup communications.
Fiji	Yes	Red Cross	National EOC	186+400			27 DPC	
FSM	All states have plans but no legislation (replaced by Executive Orders)	Red Cross US Federal Emergency Management Agency (FEMA) Small NGOs	State level	3+42 Needs not being met	Community Awareness and education programmes are under way	Single HF SSB systems with no backup	5 DPC	Human resource training, backup communications, transport support
Kiribati	Yes	Red Cross	No	18+70	Good	Gaps in coverage	1 DPC	Strengthened communications systems
Marshall Islands	Plan recently developed. Policies etc still linked	FEMA	No EOC	4+40. Not meeting the needs	Very little	National coverage	1 DPC	Community awareness and education. Maintenance and service backup for

[5] Number of people trained at regional level, between 1995-2003, source TAF/OFDA
[6] DPC – Disaster Preparedness Containers pre-positioned by Red Cross

Country	Plans, policies, legislation, structure	Key response partners	Emergency operations centre(s)	Human resources training[5]	Community preparedness	Emergency comms	Emergency stockpiles	Needs
	to US FEMA							communications
Nauru	No		No					
Niue	Yes but legislation dated	Village councils.	Temporary NEOC	12+24	Satisfactory	Gaps in communications and broadcasting coverage	None	Strengthened communications system. Development of national & village EOCs
Palau	Yes. Legislation replaced by Executive Order	Red Cross Church Groups	NEOC	12+80	Satisfactory	Gaps in coverage	1 DPC	Equipment for first responders (fire police, emergency medical service). EOC equipment
Papua New Guinea	Yes. Plan being updated	Red Cross, World Vision, CARE	NEOC	14+125			16 DPC	
Samoa	Yes. Plan being reviewed	Red Cross	NEOC	52+75. More continuity training	Currently developing new programs	None	5 DPC	Not available until the outcomes of current World Bank Project become apparent
Solomon Islands	Yes. Plan being reviewed	Red Cross, World Vision, OXFAM Womens' Organisations	NEOC	33+125	Requires further work	Gaps in coverage	7 DPC Govt store of shelter materials	Better communications coverage Support for community preparedness
Tokelau	National Plan only		No	2+11 Needs not	Mainly traditional Polynesian	Satellite phones	No	Medical response capability

Country	Plans, policies, legislation, structure	Key response partners	Emergency operations centre(s)	Human resources training[5]	Community preparedness	Emergency comms	Emergency stockpiles	Needs
	Some village plans			being met	practices			Emergency power Evacuation shelters
Tonga	Plan	Red Cross	New EOC under construction	49 + 150. More community -based training needed	Awareness is high but education needs further attention	Telephone system is used for main communicatio ns. There is currently no radio backup except the Defence network to a few islands	3 DPC	Development of a community awareness and education programmes
Tuvalu	Plan (needs revision) No legislation	Red Cross. Church Groups	National Coordination Centre	27 + 75 Not meeting the needs	Moderate	Gaps in coverage	2 DPC	Capacity building for disaster managers
Vanuatu	Yes. Some policy limitations	Red Cross, World Vision, Peace Corps Caritas	NEOC	37+100 Not meeting the need	Satisfactory	Gaps in coverage	5 DPC	Agency plans and sectoral capacity building for support plans
Regional		FRANZ countries UNOCHA IFRC						

Country	Plans, policies, legislation, structure	Key response partners	Emergency operations centre(s)	Human resources training[5]	Community preparedness	Emergency comms	Emergency stockpiles	Needs

ANNEX XI

LIST OF ACRONYMS

ADRC	Asian Disaster Reduction Centre
AEC	Association for Caribbean States
AFNOR	Association française de normalisation
ASEAN	Association of South East Asian Nations
BUD	Buffer of Uniform Data
CBS	Commission for Basic Systems
CEPREDENAC	Centro de Coordinación de la Prevención de Desastres Naturales en América Central (Coordinación Centre for the Prevention of Natural Disasters in Central America)
CO-OPS	Centre for Operational Oceanographic Products & Services
CPPT	Centre Polynésien de Prévention des Tsunamis
CTBTO	Comprehensive Nuclear Test Ban Treaty Organization
DART	Deep-ocean Assessment & Reporting of Tsunamis
DHN	Dirección de Hidrografía y Navegación
DMAC	Data Management & Communications
DMS	Data Communications & Management Subsystem
ENSO	El Niño and the Southern Oscillation (An Ocean/Atmosphere Interaction Study)
ETS	Episodic Tremor & Slip
EWS	Early Warning Systems
FDSN	Federation of Digital Broadband Seismographic Networks
GEBCO	General Bathymetric Chart of the Oceans
GEOSS	Global Earth Observation System of Systems
GITEC	Genesis and Impact of Tsunamis on the European Coasts
GLOSS	Global Sea level Observing System
GOES	USA geostationary weather satellite
GPS	Global Positioning System
GSM	Global System for Mobile Communications
GSN	Global Seismic Network
GSN	Global Seismographic Network
GTDB	Global Tsunami Data Base
GTS	Geostationary Satellite System
HTDB	Historical Tsunami Data Base
IASPEI	International Association of Seismology & the Earth's Interior

IAVCEI	International Association of Volcanology & Chemistry of the Earth's Interior
IBC	International Bathymetric Charts
ICG/CARIBE-EWS	Intergovernmental Coordination Group for the Tsunami and Other Coastal Hazards Warning System for the Caribbean and Adjacent Regions
ICG/IOTWS	Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System
ICG/ITSU	International Coordination Group for the Tsunami Warning System in the Pacific
ICG/NEAMTWS	Intergovernmental Coordination Group for the Tsunami Early Warning and Mitigation System in the North-eastern Atlantic, the Mediterranean and Connected Seas
ICG/PTWS	Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System
IDA	International Deployment of Accelerographs
IFRC	International Federation of Red Cross & Red Crescent Societies
IHO	International Hydrographic Organization
INMARSAT	French Mobile Satellite Communications Network
IOC	Intergovernmental Oceanographic Commission (of UNESCO)
IOCARIBE	IOC Sub-Commission for the Caribbean & Adjacent Regions
IODE	International Oceanographic Data & Information Exchange
IOOS	Integrated Ocean Observing System
IOTWS	Indian Ocean Tsunami Warning & Mitigation System
IPCC	Intergovernmental Panel on Climate Change
IRIS	Incorporated Research Institutions for Seismology
ISDR	International Strategy for Disaster Reduction
ISO	International Standards Organization
ITDB	Integrated Tsunami Data Base
ITIC	International Tsunami Information Centre (USA)
IUGG	International Union of Geodesy & Geophysics
JCOMM	Joint Technical Committee for Oceanography & Marine Metrology
JCOMM OPA & SPA	Joint Technical Committee for Oceanography & Marine Metrology Observing Programme Area & Service Programme Area
JCOMMOPS	Joint Technical Committee for Oceanography & Marine Metrology *in situ* Observing Platform Support Centre
JICA	Japan International Cooperation Agency

JMA	Japan Meteorological Agency
KMA	Korea Meteorological Administration
LDG/DASE	Laboratoire de Détection Géophysique/Département Analyse, Surveillance, Environnement
LISS	Live Internet Seismic Server
MLA	Main Line of Action
MSL	Mean Sea Level
NAVAREA	A World-Wide Navigational Warning Service
NESDIS	NOAA National Environmental Satellite, Data, and Information Service
NGDC	National Geophysical Data Center
NHK	Nippon Hosou Kyoukai (Japan Broadcasting Corporation)
NOAA	National Oceanic & Atmospheric Administration (USA)
NOS	National Ocean Service
NPP	Nuclear Power Plants
NTC	National Tidal Centre
NTHM	National Tsunami Hazard Mitigation Program
NTL/ICMMG	Novosibirsk Tsunami Laboratory of the Institute of Computational Mathematics & Mathematical Geophysics
NWLON	National Water Level Observation Network
NWPTA	Northwest Pacific Tsunami Advisory
NWPTAC	Northwest Pacific Tsunami Advisory Center
ODIN	Ocean Data & Information Network
PDM	Parametric Data Manager
PHIVOLCS	Philippine Institute of Volcanology and Seismology
PIC	Pacific Island Countries
PMEL	Pacific Marine Environmental Laboratory
PPEW	Platform for the Promotion of Early Warning
PTWS	Pacific Tsunami Warning and Mitigation System
RANET	Radio Internet
RDBMS	Relational Data Base Management System
ROSHYDROMET	Russian Federal Service for Hydrometeorology & Environmental Monitoring
SEAREAD	Australian Educational Programme
SHOA	Servicio Hidrografico y Oceanografico de la Armada de Chile (Naval Hydrographic & Oceanographic Service of the Armada of Chile)
SMD	Samoa Meteorology Division
SMS	Short Message Service

SOPAC	Pacific Applied Geosciences Commission
SPTAW	South Pacific Tsunami Awareness Workshop
STK	Seismic Tool Kit
TBB	Tsunami Bulletin Board
TC	Tsunami Commission
TOR	Terms of Reference
TTT	Tsunami Travel Time
TWS	Tsunami Warning System
TWSP	Tsunami Warning System in the Pacific
UHSLC	University of Hawaii Sea Level Centre
UN	United Nations
UN/OCHA	United Nations/Office for the Coordination of Humanitarian Affairs
UNESCO	United Nations Educational, Scientific & Cultural Organization
UPRM	University of Puerto Rico, Mayagüez
USGS	US Geological Survey
VSAT	Very Small Aperture Terminal (an earthbound station used in satellite communications of data)
WC/ATWC	West Coast/Alaska Tsunami Warning Center
WDC-SEG	World Data Centre for Solid Earth Geophysics (USA) - Tsunamis
WESTPAC	IOC Sub-Commission for the Western Pacific
WMO	World Meteorological Organization

In this Series *Languages*

Reports of Governing and Major Subsidiary Bodies, which was initiated at the beginning of 1984, the reports of the following meetings have already been issued:

1.	Eleventh Session of the Working Committee on international Oceanographic Data Exchange	E, F, S, R
2.	Seventeenth Session of the Executive Council	E , F, S, R,Ar
3.	Fourth Session of the Working Committee for Training, Education and Mutual Assistance	E, F, S, R
4.	Fifth Session of the Working Committee for the Global Investigation of Pollution in the Marine Environment	E, F, S, R
5.	First Session of the IOC Sub-Commission for the Caribbean and Adjacent Regions	E, F, S
6.	Third Session of the *ad hoc* Task team to Study the Implications, for the Commission, of the UN Convention on the Law of the Sea and the New Ocean Regime	E, F, S, R
7.	First Session of the Programme Group on Ocean Processes and Climate	E, F, S, R
8.	Eighteenth Session of the Executive Council	E, F, S, R, Ar
9.	Thirteenth Session of the Assembly	E, F, S, R, Ar
10.	Tenth Session of the International Co-ordination Group for the Tsunami Warning System in the Pacific	
11.	Nineteenth Session of the Executive Council, Paris, 1986	E, F, S, R, Ar
12.	Sixth Session of the IOC Scientific Committee for the Global Investigation of Pollution in the Marine Environment	E, F, S
13.	Twelfth Session of the IOC Working Committee on International Oceanographic Data Exchange	E, F, S, R
14.	Second Session of the IOC Sub-Commission for the Caribbean and Adjacent Regions, Havana, 1986	E, F, S
15.	First Session of the IOC Regional Committee for the Central Eastern Atlantic, Praia, 1987	E, F, S
16.	Second Session of the IOC Programme Group on Ocean Processes and Climate	E, F, S
17.	Twentieth Session of the Executive Council, Paris, 1987	E, F, S, R, Ar
18.	Fourteenth Session of the Assembly, Paris, 1987	E, F, S, R, Ar
19.	Fifth Session of the IOC Regional Committee for the Southern Ocean	E, F, S, R
20.	Eleventh Session of the International Co-ordination Group for the Tsunami Warning System in the Pacific, Beijing, 1987	E, F, S, R
21.	Second Session of the IOC Regional Committee for the Co-operative Investigation in the North and Central Western Indian Ocean, Arusha, 1987	E, F
22.	Fourth Session of the IOC Regional Committee for the Western Pacific, Bangkok, 1987	E only
23.	Twenty-first Session of the Executive Council, Paris, 1988	E, F, S, R
24.	Twenty-second Session of the Executive Council, Paris, 1989	E, F, S, R
25.	Fifteenth Session of the Assembly, Paris, 1989	E, F, S, R
26.	Third Session of the IOC Committee on Ocean Processes and Climate, Paris, 1989	E, F, S, R
27.	Twelfth Session of the International Co-ordination Group for the Tsunami Warning System in the Pacific, Novosibirski, 1989	E, F, S, R
28.	Third Session of the Sub-Commission for the Caribbean and Adjacent Regions, Caracas, 1989	E, S
29.	First Session of the IOC Sub-Commission for the Western Pacific, Hangzhou, 1990	E only
30.	Fifth Session of the IOC Regional Committee for the Western Pacific, Hangzhou, 1990	E only
31.	Twenty-third Session of the Executive Council, Paris, 1990	E, F, S, R
32.	Thirteenth Session of the IOC Committee on International Oceanographic Data and Information Exchange, New York, 1990	E only
33.	Seventh Session of the IOC Committee for the Global Investigation of Pollution in the Marine Environment, Paris, 1991	E, F, S, R
34.	Fifth Session of the IOC Committee for Training, Education and Mutual Assistance in Marine Sciences, Paris, 1991	E, F, S, R
35.	Fourth Session of the IOC Committee on Ocean Processes and Climate, Paris, 1991	E, F, S, R
36.	Twenty-fourth Session of the Executive Council, Paris, 1991	E, F, S, R
37.	Sixteenth Session of the Assembly, Paris, 1991	E, F, S, R, Ar
38.	Thirteenth Session of the International Co-ordination Group for the Tsunami Warning System in the Pacific, Baja California, 1991	E, F, S, R
39.	Second Session of the IOC-WMO Intergovernmental WOCE Panel, Paris, 1992	E only
40.	Twenty-fifth Session of the Executive Council, Paris, 1992	E, F, S, R
41.	Fifth Session of the IOC Committee on Ocean Processes and Climate, Paris, 1992	E, F, S, R
42.	Second Session of the IOC Regional Committee for the Central Eastern Atlantic, Lagos, 1990	E, F
43.	First Session of the Joint IOC-UNEP Intergovernmental Panel for the Global Investigation of Pollution in the Marine Environment, Paris, 1992	E, F, S, R
44.	First Session of the IOC-FAO Intergovernmental Panel on Harmful Algal Blooms, Paris, 1992	E, F, S
45.	Fourteenth Session of the IOC Committee on International Oceanographic Data and Information Exchange, Paris, 1992	E, F, S, R
46.	Third Session of the IOC Regional Committee for the Co-operative Investigation in the North and Central Western Indian Ocean, Vascoas, 1992	E, F
47.	Second Session of the IOC Sub-Commission for the Western Pacific, Bangkok, 1993	E only
48.	Fourth Session of the IOC Sub-Cornmission for the Caribbean and Adjacent Regions, Veracruz, 1992	E, S
49.	Third Session of the IOC Regional Committee for the Central Eastern Atlantic, Dakar, 1993	E, F
50.	First Session of the IOC Committee for the Global Ocean Observing System, Paris, 1993	E, F, S, R
51.	Twenty-sixth Session of the Executive Council, Paris, 1993	E, F, S, R
52.	Seventeenth Session of the Assembly, Paris, 1993	E, F, S, R
53.	Fourteenth Session of the International Co-ordination Group for the Tsunami Warning System in the Pacific, Tokyo, 1993	E, F, S, R
54.	Second Session of the IOC-FAO Intergovernmental Panel on Harmful Algal Blooms, Paris, 1993	E, F, S
55.	Twenty-seventh Session of the Executive Council, Paris, 1994	E, F, S, R
56.	First Planning Session of the IOC-WMO-UNEP Committee for the Global Ocean Observing System, Melbourne, 1994	E, F, S, R
57.	Eighth Session of the IOC-UNEP-IMO Committee for the Global Investigation of Pollution in the Marine Environment, San José, Costa Rica, 1994	E, F, S
58.	Twenty-eighth Session of the Executive Council, Paris, 1995	E, F, S, R
59.	Eighteenth Session of the Assembly, Paris, 1995	E, F, S, R
60.	Second Session of the IOC-WMO-UNEP Committee for the Global Ocean Observing System, Paris, 1995	E, F, S, R

CONTINUED ON INSIDE OF BACK COVER

61.	Third Session of the IOC-WMO Intergovernmental WOCE Panel, Paris, 1995	E only
62.	Fifteenth Session of the International Co-ordination Group for the Tsunami Warning System in the Pacific, Papetee, 1995	E, F, S, R
63.	Third Session of the IOC-FAO Intergovernmental Panel on Harmful Algal Blooms, Paris, 1995	E, F, S
64.	Fifteenth Session of the IOC Committee on International Oceanographic Data and Information Exchange	E, F, S, R
65.	Second Planning Session of the IOC-WMO-UNEP Committee for the Global Ocean Observing System, Paris, 1995	E only
66.	Third Session of the IOC Sub-Commission for the Western Pacific, Tokyo, 1996	E only
67.	Fifth Session of the IOC Sub-Commission for the Caribbean and Adjacent Regions, Christ Church, 1995	E, S
68.	Intergovernmental Meeting on the IOC Black Sea Regional Programme in Marine Sciences and Services	E, R
69.	Fourth Session of the IOC Regional Committee for the Central Eastern Atlantic, Las Palmas, 1995	E, F, S
70.	Twenty-ninth Session of the Executive Council, Paris, 1996	E, F, S, R
71.	Sixth Session for the IOC Regional Committee for the Southern Ocean and the First Southern Ocean Forum, Bremerhaven, 1996	E, F, S,
72.	IOC Black Sea Regional Committee, First Session, Varna, 1996	E, R
73.	IOC Regional Committee for the Co-operative Investigation in the North and Central Western Indian Ocean, Fourth Session, Mombasa, 1997	E, F
74.	Nineteenth Session of the Assembly, Paris, 1997	E, F, S, R
75.	Third Session of the IOC-WMO-UNEP Committee for the Global Ocean Observing System, Paris, 1997	E, F, S, R
76.	Thirtieth Session of the Executive Council, Paris, 1997	E, F, S, R
77.	Second Session of the IOC Regional Committee for the Central Indian Ocean, Goa, 1996	E only
78.	Sixteenth Session of the International Co-ordination Group for the Tsunami Warning System in the Pacific, Lima, 1997	E, F, S, R
79.	Thirty-first Session of the Executive Council, Paris, 1998	E, F, S, R
80.	Thirty-second Session of the Executive Council, Paris, 1999	E, F, S, R
81.	Second Session of the IOC Black Sea Regional Committee, Istanbul, 1999	E only
82.	Twentieth Session of the Assembly, Paris, 1999	E, F, S, R
83.	Fourth Session of the IOC-WMO-UNEP Committee for the Global Ocean Observing System, Paris, 1999	E, F, S, R
84.	Seventeenth Session of the International Coordination Group for the Tsunami Warning System in the Pacific, Seoul, 1999	E, F, S, R
85.	Fourth Session of the IOC Sub-Commission for the Western Pacific, Seoul, 1999	E only
86.	Thirty-third Session of the Executive Council, Paris, 2000	E, F, S, R
87.	Thirty-fourth Session of the Executive Council, Paris, 2001	E, F, S, R
88.	Extraordinary Session of the Executive Council, Paris, 2001	E, F, S, R
89.	Sixth Session of the IOC Sub-Commission for the Caribbean and Adjacent Regions, San José, 1999	E only
90.	Twenty-first Session of the Assembly, Paris, 2001	E, F, S, R
91.	Thirty-fifth Session of the Executive Council, Paris, 2002	E, F, S, R
92.	Sixteenth Session of the IOC Committee on International Oceanographic Data and Information Exchange, Lisbon, 2000	E, F, S, R
93.	Eighteenth Session of the International Coordination Group for the Tsunami Warning System in the Pacific, Cartagena, 2001	E, F, S, R
94.	Fifth Session of the IOC-WMO-UNEP Committee for the Global Ocean Observing System, Paris, 2001	E, F, S, R
95.	Seventh Session of the IOC Sub-commission for the Caribbean and Adjacent Regions (IOCARIBE), Mexico, 2002	E, S
96.	Fifth Session of the IOC Sub-Commission for the Western Pacific, Australia, 2002	E only
97.	Thirty-sixth Session of the Executive Council, Paris, 2003	E, F, S, R
98.	Twenty-second Session of the Assembly, Paris, 2003	E, F, S, R
99.	Fifth Session of the IOC Regional Committee for the Co-operative Investigation in the North and Central Western Indian Ocean, Kenya, 2002 (* Executive Summary available separately in E, F, S & R)	E*
100.	Sixth Session of the IOC Intergovernmental Panel on Harmful Algal Blooms, St. Petersburg (USA), 2002 (* Executive Summary available separately in E, F, S & R)	E*
101.	Seventeenth Session of the IOC Committee on International Oceanographic Data and Information Exchange, Paris, 2003 (* Executive Summary available separately in E, F, S & R)	E*
102.	Sixth Session of the IOC-WMO-UNEP Committee for the Global Ocean Observing System, Paris, 2003 (* Executive Summary available separately in E, F, S & R)	E*
103.	Nineteenth Session of the International Coordination Group for the Tsunami Warning System in the Pacific, Wellington, New Zealand, 2003 (* Executive Summary available separately in E, F, S & R)	E*
104.	Third Session of the IOC Regional Committee for the Central Indian Ocean, Tehran, Islamic Republic of Iran, 21-23 February 2000	E only
105.	Thirty-seventh Session of the Executive Council, Paris, 2004	E, F, S, R
106.	Seventh Session of the IOC-WMO-UNEP Committee for the Global Ocean Observing System, Paris, 2005 (* Executive Summary available separately in E, F, S & R); and Extraordinary Session, Paris, 20 June 2005	E*
107.	First Session of the Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWS), Perth, Australia, 3–5 August 2005	E only
108.	Twentieth Session of the Intergovernmental Coordination Group for the Tsunami Warning System in the Pacific, Viña del Mar, Chile, 3–7 October 2005 (* Executive Summary available separately in E, F, S & R)	E*
109.	Twenty-Third Session of the Assembly, Paris, 21–30 June 2005	E, F, S, R
110.	First Session of the Intergovernmental Coordination Group for the Tsunami Early Warning and Mitigation System in the North Eastern Atlantic, the Mediterranean and Connected Seas (ICG/NEAMTWS), Rome, Italy, 21–22 November 2005	E only
111.	Eighth Session of the IOC Sub-commission for the Caribbean and Adjacent Regions (IOCARIBE), Recife, Brazil, 14–17 April 2004 (* Executive Summary available separately in E, F, S & R)	E*
112.	First Session of the Intergovernmental Coordination Group for the Tsunami and other Coastal Hazards Warning System for the Caribbean Sea and Adjacent Regions (ICG/CARIBE-EWS), Bridgetown, Barbados, 10–12 January 2006	E only
113.	Ninth Session of the IOC Sub-Commission for the Caribbean and Adjacent Regions (IOCARIBE), Cartagena de Indias, Colombia, 19–22 April 2006 (* Executive Summary available separately in E, F, S & R)	E S*

114.	Second Session of the Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWS), Hyderabad, India, 14–16 December 2005	E only
115.	Second Session of the WMO-IOC Joint Technical Commission for Oceanography and Marine Meteorology, Halifax, Canada, 19–27 September 2005 (Abridged final report with resolutions and recommendations)	E, F, R, S
116.	Sixth Session of the IOC Regional Committee for the Western Indian Ocean (IOCWIO), Maputo, Mozambique, 2–4 November 2005 (* Executive Summary available separately in E, F, S & R)	E*
117.	Fourth Session of the IOC Regional Committee for the Central Indian Ocean, Colombo, Sri Lanka 8–10 December 2005 (* Executive Summary available separately in E, F, S & R)	E*
118.	Thirty-eighth Session of the Executive Council, Paris, 20 June 2005 (Electronic copy only)	E, F, R, S
119.	Thirty-ninth Session of the Executive Council, Paris, 21–28 June 2006	E, F, R, S
120.	Third Session of the Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWS), Bali, Indonesia, 31 July–2 August 2006 (*Executive Summary available separately in E,F,S & R)	E*
121.	Second Session of the Intergovernmental Coordination Group for the Tsunami Early Warning and Mitigation System in the North Eastern Atlantic, the Mediterranean and Connected Seas (ICG/NEAMTWS), Nice, France, 22–24 May 2006	E only
122.	Seventh Session of the IOC Intergovernmental Panel on Harmful Algal Blooms, Paris, France, 16–18 March 2005 (* Executive Summary available separately in E, F, S & R)	E*
123.	Fourth Session of the Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWS-IV), Mombassa, Kenya, 30 February-2 March 2007 (* Executive Summary available separately in E, F, S & R)	E*
124.	Nineteenth Session of the IOC Committee on International Oceanographic Data and Information Exchange, Trieste, Italy, 12–16 March 2007 (* Executive Summary available separately in E, F, S & R)	E*
125.	Third Session of the Intergovernmental Coordination Group for the Tsunami Early Warning and Mitigation System in the North Eastern Atlantic, the Mediterranean and Connected Seas, Bonn, Germany, 7–9 February 2007 (* Executive Summary available separately in E, F, S & R)	E*
126.	Second Session of the Intergovernmental Coordination Group for the Tsunami and other Coastal Hazards Warning System for the Caribbean Sea and Adjacent Regions, Cumaná, Venezuela, 15–19 January 2007 (* Executive Summary available separately in E, F, S & R)	E*
127.	Twenty-first Session of the Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System, Melbourne, Australia, 3–5 May 2006 (* Executive Summary available separately in E, F, S & R)	E*