Intergovernmental Oceanographic Commission
Reports of Meetings of Experts and Equivalent Bodies

Regional Working Group on Tsunami Warning and Mitigation System for the South China Sea Region (SCS-WG)

First Meeting

Sanya, China
12–14 December 2011

UNESCO

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ICG/PTWS-WG-SCS-I/3 Rev.
Paris, May 2012
English only

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1. OPENING OF THE MEETING

The Chair of the Regional Working Group on Tsunami Warning and Mitigation System for the South China Sea Region (SCS-WG), Dr Mohd. Rosaidi bin Che Abas, Malaysia, welcomed the delegates to the meeting. He noted with regret that not all SCS-WG member countries were able to attend, but expressed confidence that the meeting would be productive and that the outcomes would be shared with all member countries.

Dr Rosaidi asked those present to introduce themselves to each other and then invited Dr Zhanhai Zhang, Director General of the International Cooperation Department, State Oceanic Administration (SOA) of China, to open the meeting.

Dr Zhang welcomed all the delegates and recalled the 24th Session of the Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System (ICG/PTWS) and the progress made towards developing a Tsunami Warning and Mitigation System for the South China Sea. Dr Zhang stated that SOA was delighted to host the meeting and he introduced the responsibilities of the National Marine Environmental Forecasting Centre (NMEFC), which had organized and sponsored the meeting. Dr Zhang noted that SOA attached great importance to marine hazard forecasts, including tsunami, and also touched on the PacWave11 exercise (IOC/2011/TS/97VOL.1), which would be fully discussed in the coming meeting. Dr Zhang wished everybody a successful meeting and a pleasant stay in Sanya, China.

Dr Rosaidi thanked Dr Zhang and invited Mr Tony Elliott, Head of the Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWS) Secretariat and Technical Secretary for the SCS-WG, to deliver his opening speech.

Mr Elliott thanked Dr Zhang and welcomed everybody to the meeting on behalf of the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational, Scientific and Cultural Organization (UNESCO). He recalled the sessional meeting of the SCS-WG held at the 24th Session of ICG/PTWS and acknowledged the present tsunami warning providers relevant to the region, namely, Japan Meteorological Agency (JMA) and Pacific Tsunami Warning Center (PTWC). He reminded the delegates of the three pillars of an end-to-end tsunami warning system, which were: risk assessment and reduction; detection, warning and dissemination; and awareness and preparedness. He encouraged members to become more involved in the Working Group (WG), especially at this time of budget shortage, which resulted from the withholding of the United States of America of its annual contributions to UNESCO. He thanked NMEFC, SOA, and China for hosting and sponsoring the meeting and wished everybody a productive and fruitful meeting.

Dr Rosaidi thanked Dr Zhang and Mr. Elliott for their opening remarks. He expressed the hope that the IOC would continue to support the SCS-WG and to give priority to the regional tsunami warning system. He noted that the South China Sea was very sensitive in a political sense, and reminded delegates to be cautious about that. He concluded by thanking the SOA and the Chinese government for hosting the meeting.

Dr Rosaidi then invited Mr Takeshi Koizumi (Japan), Vice-Chair of the ICG/PTWS, to deliver his opening remarks. Mr Koizumi expressed regret that the Chair of the ICG/PTWS was unable to attend the meeting due to illness. He noted that the South China Sea is vulnerable to tsunami as there are major tsunamigenic source zones in the region and propagation times are very short. It is therefore essential to monitor and share seismic and sea level data.

Mr Koizumi officially declared the meeting open.

2. ORGANISATION OF THE SESSION

2.1 ADOPTION OF THE AGENDA

The provisional agenda circulated prior to the meeting **was adopted** and is available in Annex I. The full list of participants is provided in Annex IV.

2.2 DESIGNATION OF RAPPORTEUR

The nomination of Dr Long Jiang as rapporteur made by Mr Yafeng Yang (China) was accepted by the delegates.

2.3 CONDUCT OF THE SESSION, TIMETABLE AND DOCUMENTATION

The Chair went through the timetable for the meeting and requested feedback from the participants. He emphasized that all participants were expected to read through China's proposal (attached as Annex II) and were encouraged to voice their opinions on it.

3. PACWAVE11 RESULTS IN THE SOUTH CHINA SEA REGION

3.1 PACWAVE11 RESULTS IN THE SOUTH CHINA SEA REGION AND LESSONS LEARNT

Mr Sallehuddin Haji Ibrahim reported that the Brunei Disaster Administration Department took part in the exercise. It received information from PTWC, and disseminated warnings by fax, telephone and text message within 3 to 4 minutes. There were no written Standard Operating Procedures (SOP) for tsunami warning in Brunei at the moment, but they will be ready soon. An earthquake monitoring system will be established within 6 months.

Dr Yuan Ye from NMEFC, China, presented comprehensive results of the Exercise Pacific Wave 2011 (PacWave11). NMEFC sent out the first warning message within 10 minutes after receiving seismic information from PTWC. The warning was disseminated by fax, email, text message, etc. China provided detailed and descriptive analysis of the event, including simulation of propagation, arrival time, and distribution of maximum amplitude, impacts on major infrastructures, facilities and properties. Involvement of the general public, media coverage, and governmental agencies secured a successful exercise. Two tsunami buoys have been commissioned, one made in the United States of America and the other in Italy.

The Hong Kong Observatory (HKO) also participated in the exercise and Mr Mok Hing-Yim provided further details. The exercise was conducted as a real-time functional exercise and 23 government departments plus the airport authority took part. For the exercise scenario of M9.0, it was predicted a wave of 10 meters. An exercise training team was set up. The HKO simulated sea level during the exercise. The exercise tested intergovernmental communications without involving the public. Beneficial outcomes of the exercise were that awareness at the governmental level was greatly enhanced; the compilation of inundation maps was also promoted; and the Lands Department has started to develop them. These will be sensitive because of property values. Mr Mok Hing-Yim noted the consequences of false alarms for Hong Kong, for example, the airport would have to be evacuated. A warning of a wave of 10 meters would cause chaos; therefore, real time sea level monitoring is very important. For this reason, Hong Kong is very pleased to know that SOA has deployed tsunami buoys in South China Sea (SCS).

Dr Wandono reported that Indonesia had only conducted the PacWave11 exercise at the National Tsunami Warning Centre (NTWC) and had not engaged any other agencies. He reported

that Indonesia had only received one fax message from PTWC and one from JMA. The same JMA fax message was resent several times, it may have been due to a faulty fax receiver.

After some discussion on this issue it was clarified that only one Exercise Start Fax Message had been issued by PTWC and JMA and that each county then had the responsibility to conduct the exercise according to their selected scenario. All subsequent messages were available on the PTWC and JMA websites.

Mr Elliott (Secretariat) informed that the meeting about the decisions taking by the IOTWS at a recent meeting in Jakarta. Feedback from the Exercise Indian Ocean Wave 2011 (IOWave11) showed that only about 25% of faxes had been received. The IOTWS had decided to send two faxes per country, and put the onus on the receiving centre to maintain dedicated fax machines to receive messages.

Dr Rosaidi reported that Malaysia held evacuations in two places, Kudat and Labuan. In Kudat, 9 villages and about 800 people were involved. In Labuan, 3 villages and 300 people were involved. The timing of the warning was modified to take into account the availability of the villagers and resource persons. Bulletins were received from PTWC and JMA at 10:00 a.m. and sirens were activated at 11:00 a.m., followed by a 1 hour evacuation drill. A media briefing was held after the evacuation.

Dr Zhang enquired how soon Malaysia issued warnings after receiving bulletins from PTWC/JMA. Dr Rosaidi explained that Malaysia delayed issuing warnings to minimize disruption, generally to 1−1.5 hours before expected arrival time. Malaysia has a tsunami database covering the Indian Ocean and South China Sea in which they trust.

Dr Jane Punongbayan noted that in Philippines, local tsunami arrival times are between 2 to 40 minutes, regional tsunamis arrive with 1 to 3 hours and teletsunamis arrive between 3 to 24 hours. Philippines conducted a functional exercise involving the Philippine Institute of Volcanology and Seismology (PHIVOLCS) and the Office of Civil Defense (OCD) and exercise controllers were used. Philippines also delayed its warnings by more than 1 hour. Four alert levels are defined but this is quite confusing, even for the technical staff. Cancellation of warnings should be properly addressed and should be received by the correct people.

Dr Punongbayan noted that this was the first time that Philippines had exercised a local tsunami source. Dr Bart Bautista commented that in Philippines there were compulsory evacuation orders for big earthquakes, but these risks false alarms. From this exercise, they learnt that is necessary to develop a SOP for local tsunamis.

4. RISK ASSESSMENT AND REDUCTION

4.1 TSUNAMI HAZARD IN THE SOUTH CHINA SEA

Mr Lianda Zhao reviewed historical events affecting China, especially in 1969, 1992, 1994, 1988 (Philippines), and 2006. Examples of the Chilean 2010 and Japan 2011 tsunamigenic events were presented in detail. He described the risk of potential tsunamis to China and highlighted the risk levels along Chinese coastlines.

Mr Masahiro Yamamoto (Secretariat) commented that since China is a country of long history, more paleotsunami history may be found from literature. It would be a big project, but valuable for risk assessment.

Dr Rosaidi commented that Malaysia has done modelling for the Andaman Sea, South China Sea, Sulawesi Sea and Sulu Sea. In the South China Sea, a wave of 5.6 meter height is

possible for a M9.0 earthquake in the Manila Trench. In the Sulawesi Sea, a wave height of 28.9 meters was predicted for a magnitude 9.0 earthquake at Semporna with an arrival time of 40 minutes. Predicted tsunami heights and arrival times are used to estimate evacuation routes and times for worst case scenarios. Further studies are required in the South China Sea to investigate seismotectonics.

Dr Zhang enquired if a M9.0 earthquake had ever been recorded in the Sulu Sea. Dr Rosaidi responded that according to historical records a M8.6 event had occurred in the Sulu Sea.

Mr Yamamoto commented that the IOC tries to work together with the scientific community to derive realistic magnitudes for risk assessments. This will be a major challenge for this Working Group.

Dr Bautista noted that hazard maps require high resolution bathymetry and usually these data are not available in the South China Sea region.

Dr Bautista described how Philippines has derived a first generation tsunami hazard map, based on a propagation model and the use of Green's function to estimate inundation. The intention is to cover all coastlines that are vulnerable to tsunami. The inundation maps are distributed to the local government level and are used to prepare evacuation plans and to promote community preparedness.

A general discussion on the need for risk assessment was held. Mr Elliott stressed the need to assess the risk of tsunami occurring based on sound science, otherwise it will be difficult to obtain political backing and funding for a Regional Tsunami Warning System. The risk assessment should be conducted early in the process to inform the design of any system.

Mr Koizumi reiterated that risk assessment should be based on sound scientific research into what magnitude of earthquake is realistically possible in the region.

4.2 HAZARD MITIGATION IN THE SOUTH CHINA SEA

Dr Liu Guimei explained how NMEFC deal with marine hazard forecasting in China, especially for storm surge, large waves, sea ice, and tsunami.

Dr Zhang enquired about Philippines experience in forecasting typhoons, storm surges and other hazards. Dr Punongbayan explained that storm surge hazard maps were being used to guide evacuation planning. Dr Bautista commented that a multihazard approach is more sustainable in the long term.

Mr David Thomas from the World Meteorological Organization (WMO) enquired if submarine volcanoes and landslides were also a concern to the Tsunami Warning Centre (TWC), citing a volcanic eruption in New Guinea as an example. Mr Takeshi noted that it was not realistic to design a warning centre for a volcanic or landslide scenario as these are difficult to predict.

Dr Rosaidi commented that Malaysia has concentrated more on enhancing its tsunami early warning system rather than developing physical mitigation structures. For example, it has increased the number of seismometers and tide gauges; it operates and enhanced its warning dissemination through sirens and other methods.

Dr Bautista explained that Philippines did not have any physical mitigation structures because of the expense, but concentrated more on preparedness and proper land use as well as developing its tsunami warning system. He informed that Philippines is helping local communities

to develop their own tsunami warning systems based on simple technology such as wet sensors. The sensors are placed inside bays, where the tsunami wave slows down, and can provide about 30 minutes warning to communities in the bay.

Mr Koizumi provided an example of a dike at Kamaishi in Japan that had been destroyed by the tsunami on 11 March 2011. Many such structures were overtopped and some were destroyed during the event, but they had reduced the height and force of the tsunami, so they had provided some protection.

5. DETECTION, WARNING AND DISSEMINATION

5.1 EARTHQUAKE MONITORING SYSTEM

Mr Sallehuddin reported that Brunei will be installing a seismic monitoring system by mid−2012.

Mr Mok reported that the Hong Kong Observatory currently has two broadband seismometers, one of which (Po Shun) is available on the Global Seismic Network (GSN). Hong Kong also operates eight Short Period sensors and five Strong Motion sensors. Hong Kong is urbanized and close to the sea, so it is not ideal for seismic measurements. Data analysis is by Antelope incorporating data from the GSN and other overseas seismic stations. Various messages are disseminated. Quick earthquake messages are automatic, and are delivered about 10 minutes after the event for all events greater than M6.0 worldwide. Strong earthquake reports are also issued for earthquakes greater than M6.0 but are delivered manually about 20 minutes after the origin time. In the future, the Hong Kong Observatory plans to enhance its Antelope capability, improve its regional cooperation and enhance its local seismic network for detection of seismic intensity.

Dr Punongbayan asked if the Hong Kong Observatory's network is independent of the China Earthquake Authority's (CEA) network. Mr Mok explained that CEA data over the GSN is delayed by about 15 minutes.

Mr Yamamoto enquired how many earthquakes Hong Kong had experienced. Mr Mok replied that Hong Kong experienced about two felt earthquakes per year, on average, mostly originating in the South China Sea. The maximum intensity experienced in Hong Kong is about 5 on the Mercalli intensity scale.

Dr Yu Fujiang reported that the China Earthquake Authority currently operated 1,021 seismic stations. However the primary focus of CEA is not tsunami warning and the seismic data are not available in real time. The SOA is planning to install 40 broadband seismometers along the coastline in the next two to three years.

Mr Yamamoto noted that the CEA data is not available until about 30 minutes after an event and is therefore of limited use for tsunami warning purposes. He encouraged the SOA to discuss this issue with CEA to find out if data could be made available in near real time.

Dr Wandono provided an overview of the Indonesian seismic network, which currently has 160 broadband seismometers and 220 accelerometers. The Indonesian Tsunami Early Warning System (InaTEWS) takes 3 minutes to determine an earthquake location, and 5 minutes to disseminate a warning.

Dr Bautista enquired about the possibility of data sharing. He noted that Philippines can obtain data from GFZ (GeoForschungsZentrum) but with a delay of about 2 to 3 minutes. Dr Wandono confirmed that it should be possible to obtain data from Indonesia directly on a

bilateral basis. Dr Rosaidi further confirmed that this could be facilitated through the Association of South-East Asian Nations (ASEAN) process.

Mr Yamamoto reminded the group that seismic data from the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) network of primary and secondary stations is available to recognised Tsunami Warning Centres and encouraged the Member States to take advantage of this opportunity to enhance their detection capability.

Dr Rosaidi provided details of Malaysia's national, regional and international seismic data collection networks. Malaysia uses Antelope, Earlybird and Seiscomp3 to analyse data and disseminates earthquake information by SMS, Fax, internet, fixed phone lines, TV and radio. The national network comprises 10 broadband and 7 short period stations. Data from 7 of the broadband stations are shared over IRIS (Integrated Regional Information Networks). Every station is installed with an accelerometer and data is transmitted by VSAT (Very Small Aperture Terminal), i.e., in real time. Ten strong motion stations are installed around Kuala Lumpur. In addition to the national network, data is obtained from 8 stations in Indonesia and 26 other international stations. Earthquake locations and magnitudes can currently be determined within 12 minutes and it is hoped to reduce this to 10 minutes in 2012.

Dr Bautista provided details of Philippines' seismic monitoring network. Philippines operates 64 seismic stations: 34 are manned, non-real time stations and 30 are real time, using VSAT communications. All stations have short-period sensors. The 34 manned stations also have strong motion sensors. Eight stations are broadband, but these are not real time. One broadband station is now available in real time over the internet. In addition, Philippines has access to 1 CTBTO station over VSAT and 1 RIMES station, also over VSAT to Bangkok. This data is being received over IRIS with a latency of 1−1.5 minutes. A new supported project between the Japan International Cooperation Agency (JICA) and the Japan Science and Technology Agency (JST) will upgrade 10 of the real time short period seismic stations to broadband stations, also equipped with accelerometers, with data shared over IRIS. There will also be 110 seismic intensity stations installed as part of this project. PHIVOLCs use Hydra V1.47 from Nanometrix and also receiving data from Malaysia and Indonesia, coming up with earthquake parameters in 5 minutes, depending in the location. As a backup system PHIVOLCS uses Seiscomp3 and has access to around 120 stations globally over IRIS. Seiscomp3 will be the official platform for sharing data with other countries using Seedlink.

Mr Yamamoto presented a slide showing the seismic stations available over IRIS in the region. Dr Rosaidi requested Philippines and Vietnam to provide its seismic data on the IRIS network as soon as possible, as this data will be very important for rapid and accurate earthquake detection.

5.2 SEA LEVEL MONITORING SYSTEM

Mr Sallehuddin informed the group that Brunei relied on neighbouring countries for monitoring sea level. The Marine Department monitors for high tides and will alert the public if there is a combination of high tides and heavy rainfall. There are plans to establish sea level monitoring stations in 2012, but not in real time.

Dr Yu Fujiang reported that SOA has deployed two tsunameter buoys in the South China Sea since 2010. The buoys use the Iridium network for communications. SOA have also installed 107 tide gauges along the South China Sea coastline with 1 minute sampling intervals, in real time.

Mr Elliott enquired if the sea level data could be shared on international networks such as the IOC Sea Level Monitoring Service. Dr Yu noted that the tide gauge network was operated by

the National Marine Data and Information Service (NMDIS) of SOA and he would consult with them to find out if any of the data can be shared.

Mr Mok reported that in Hong Kong, data from 10 sea level stations are shared and open to the public.

Dr Wandono reported that Indonesia had about 58 sea level gauges operating out of a total of 80 planned stations. At present, only 1 tsunameter buoy is operational out of a total of 23 planned. Indonesia is facing major problems with vandalism.

Dr Rosaidi reported that Malaysia had installed 21 tide gauges around the coast of Malaysia. The focus was primarily on Sabah due to its higher risk of tsunami. Malaysia has installed 3 tsunameter buoys at Pulau Rondo, Layang-Layang and Sipidan. The Rondo buoy has disappeared but Malaysia will replace it. The other 2 buoys are still on location. Malaysia is not sharing data on the GTS (Global Telecommunication System) yet because they are waiting for the data to stabilise. Malaysia is also waiting for data from its national network of sea level stations to stabilise before sharing data on the GTS, which it hoped to do very soon.

Dr Bautista reported that Philippines had installed 5 real time sea level stations; 3 are on the South China Sea coast, and 2 are on the Pacific Ocean coast. NAMRIA (National Mapping and Resource Information Authority) is the agency in charge of monitoring sea level. There are also 3 RIMES sea level stations in Philippines. Philippines uses “wet sensors” to detect when tsunami reaches the shore and recently they have made these community-based. The sensors are placed at strategic locations to give as much warning as possible to coastal communities. Philippines is also developing ultra-sonic sensors and a mass alerting system linked to sirens. This system allows rapid warning using cellphone triggered sirens, which is more practical and less expensive than maintaining buoys.

5.3 INFORMATION SHARING PLATFORM

Dr Yuen informed the meeting that the NMEFC currently operates a website and FTP server and that it can communicate with regional and provincial centres using VSAT. It can also receive data from more than 50 sea level stations using VSAT. In addition, China receives tsunami warnings and shared sea level data over the GTS.

Mr Koizumi enquired if NMEFC could obtain GTS data. Dr Yuen replied that NMEFC received GTS messages from the China Meteorological Agency (CMA), but not all messages, only those relevant to NMEFC.

A discussion on the sharing of data and information among the SCS-WG Member States then took place. China suggested that there should be a specific data sharing platform for the Member States that could be operated by NMEFC. Dr Rosaidi wanted to know if sharing of seismic data could be done more quickly than using IRIS. He asked the individual countries if they would have any problem sharing data on a new platform. Philippines responded that it would not have any problem.

Mr Koizumi stressed the importance of focusing on policy rather than hardware in the proposal. The IRIS platform may be sufficient, but the most important point is that there should be an agreed mechanism for sharing data.

Dr Bautista commented that with regard to seismic data, most Indian Ocean states that are members of RIMES use Seiscomp3 for sharing data. Dr Rosaidi noted that Seiscomp3 is becoming the standard mechanism for sharing seismic data. Each country can connect to other countries to share the data; but bandwidth can be a problem if many countries try to connect at the

same time. Dr Bautista commented that this was why Philippines only pushed its data to IRIS, leaving it up to other countries to connect to IRIS to receive the data.

Dr Punongbayan commented that Philippines had no objection sharing its data over IRIS but wanted to know what other countries thought. Dr Mok commented that Hong Kong was already pushing its data to IRIS. China was unable to commit to pushing real time data to IRIS although it already pushes data with a 30 minute delay.

Indonesia reported that it pushes its data to GFZ and GFZ pushes this to IRIS, so it is accessible by other countries.

Dr Rosaidi summarised that IRIS should be used for the sharing of data among Member States.

Mr Yafeng Yang commented that China could set up another information centre for sharing regional data in addition to IRIS. He also noted that this could be used for sharing other information, such as tsunami warnings tailored for use in the South China Sea. It could also be used for sharing documents, scientific knowledge, etc.

Dr Rosaidi noted that ASEAN countries had a similar information centre at the ASEAN Earthquake Information Centre (AEIC).

Mr Yafeng Yang commented that the platform should be wider than the centre itself, and each country should contribute to it. As well as hardware it should be a means for countries to share data.

Mr Yamamoto commented that any regional centre would need to be integrated within the PTWS and that there would need to be further discussion about this within the PTWS. He asked why the South China Sea needed a regional warning centre. No other sub-regional working groups had discussed establishing separate warning centres. He felt that the SCS-WG should focus on mechanisms for sharing data and remain integrated with the PTWS. This is the first case in the world for establishing a sub-regional warning centre.

Mr Elliott noted that the role of the SCS-WG is advisory to the PTWS and he advised that the group should focus on issues of importance to the region within the framework of the PTWS.

Mr Yamamoto commented that the challenge for the countries of the region was to work together to build a system that could provide earthquake and tsunami information before the PTWS regional warning centres can, and therefore provide more lead time, otherwise there would be no added value.

Mr Koizumi clarified that the target Mr Yamamoto mentioned would be one of the choices and urged the group to think carefully about these issues including developing sub-regional cooperation to provide improved tsunami warning capability, and cooperation on scientific research and capacity building.

Mr Yafeng Yang agreed with Mr Koizumi and also noted that the sub-regional warning system could be used to promote capacity building in the region.

Mr Elliott commented that the Indian Ocean Regional Tsunami Service Providers (RTSPs) are taking over the role of regional tsunami advisory providers from the PTWC and JMA and will become the regional centres for the Indian Ocean when the transition is complete. However, there was no question that the PTWC and JMA would cease providing services to the South China Sea region. The concept of issuing separate warnings for the South China Sea region therefore needs

to be considered in the whole framework of the PTWS, because each of the Member States will also be receiving bulletins from PTWC and JMA. If the SCS-WG decides that there is a need for separate warnings for the sub-region, then it will need to be discussed at the ICG/PTWS level. In the meantime, the promotion of data and information sharing in the sub-regional context falls exactly within the SCS-WG's Terms of Reference and should be encouraged.

World Meteorological Organization (WMO) Presentation

Mr David Thomas (WMO) gave a presentation on the WMO Information System (WIS). He first provided an overview of the history of the GTS, which has evolved from the old telegram infrastructure. He explained that GTS is based on "push" technology and a daisy chain infrastructure of centres around the globe. The nature of the GTS is such that if one centre is slow, then it will slow the whole system down. He described how GTS was used to disseminate DART II (Deep-ocean Assessment and Reporting of Tsunamis) tsunameter buoy data, and explained the CREX (Character Form for the Representation and Exchange of Data) sea level data structure. Mr Thomas then explained that the GTS is no longer satisfactory because of the amount of information being shared on it. The WIS is being developed to provide connectivity between all WMO programmes, the World Weather Watch and other partners. He provided an overview of the structure of WIS, described its Service Oriented Architecture, and explained how it could be utilised by end users. The WIS will become operational in June 2012, and WMO will be organising training courses in the regions.

On behalf of the IOC, Mr Elliott requested WMO to arrange training in WIS for South China Sea countries.

5.4 TSUNAMI WARNING CENTRE

Mr Sallehuddin stated that in Brunei Darussalam, the Meteorological Department is the National Tsunami Warning Centre (NTWC). It passes bulletins received from the Pacific Tsunami Warning Center (PTWC) to the National Disaster Management Centre (NDMC) without alteration.

Dr Yu reported that the National Marine Environmental Forecasting Centre (NMEFC) is responsible for tsunami warning in China. A new, integrated, facility will be completed in 2012. The NMEFC operates high performance computers. The warning centre operates 24x7 and disseminates tsunami bulletins and warnings by internet, fax, broadcasts etc. In 2011, the NMEFC issued 110 bulletins including 2 warnings. Forecasting products are produced and disseminated to the public by: TV programmes, broadcasting programmes, website, "weibo", newspapers, LCD in fishing ports and beaches. Forecasts and warnings are disseminated to government departments and agencies by parallel digital fax, short messages and telephone.

Dr Yu then described the tsunami warning procedures followed by NMEFC. The centre holds a quantitative tsunami forecasting system database for the South China Sea comprising 7,050 scenarios, and forecasting results are available 1 minute after input of earthquake information. Tsunami wave height forecasts are displayed as colour-coded coastal zones, and arrival time contours are also displayed. Dr Yu presented model validation results for the 26 December 2006 southern Taiwan tsunami and the 27 February 2010 Chile tsunami.

Dr Yu went on to describe the CTSU-OMP tsunami model operated by NMEFC covering the NW Pacific, including validation results for events in 2006 and 2007 in the Kuril Islands, and the Peru tsunami of August 2007. He explained the Rapid Tsunami Warning System (RTWS) procedure developed by NMEFC, which is based on a Reciprocal Green's Function (RGF), and provided a comparison of results between the COMCOT (Cornell Multi-grid Coupled Tsunami) model and the RTWS-RGF approach, noting that the COMCOT model takes about 5 to 20 seconds to run on a computer server, whereas the RTWS-RGF model takes about 8 to 10 seconds

on a laptop computer. He described the RTWS graphic interface and summarized the advantages of the RTWS, which are that it is more efficient, requires a smaller database, has a lower hardware requirement and is easier to operate. He provided an example of a real case: the 11 March 2011 Japan tsunami. The model results were generated within 10 minutes and compared well with sea level gauge observations.

Mr Mok commented that the Hong Kong Observatory is the warning centre for Hong Kong. It will issue a tsunami warning if a tsunami wave of >0.5 m is forecast to arrive within 3 hours. If it is expected to arrive in longer than 3 hours, a tsunami information bulletin will be issued first, as there will be time to respond.

Dr Wandono reported on the status of Indonesia's Tsunami Warning Centre. He described data and information flow and the Decision Support System operated by Indonesia. There are three levels of threat: Advisory; Warning and Major Warning. A Digital Video Broadcast (DVB) satellite based system is used to disseminate warnings to local government within 4 minutes. There are 145 DVB sites in Indonesia as of 2010.The Indonesian Tsunami Early Warning System (InaTEWS) has two roles: National Tsunami Warning Centre (NTWC) and Regional Tsunami Service Provider (RTSP). The InaRTSP seismic and sea level networks are different from the national networks. Dr Wandono provided an example of an InaRTSP tsunami scenario and described the system performance since 2008. He went on to describe the InaRTSP dissemination tools, procedures and systems, and the staffing and facilities dedicated to the service. He listed the criteria for issuing RTSP bulletins and described the products that are disseminated.

Dr Rosaidi provided a report on the status of the Malaysian National Tsunami Early Warning System (MNTEWS). Prior to 2010, the MNTEWS was able to issue earthquake information and tsunami warnings within 15 minutes for warning. After 2010, this reduced to within 12 minutes and the target is to improve to less than 10 minutes in 2012. Malaysia is also working towards becoming an Indian Ocean RTSP by 2012. Dr Rosaidi described the main components of the MNTEWS, which include a Data and Information Collection Component, a Processing Component and a Dissemination Component. He gave an overview of the national seismic and sea level monitoring networks, and the coastal camera network. He explained that Malaysia has developed tsunami scenario databases for the Indian Ocean (including the Makran source zone) and the South China Sea. The estimated total number of scenarios in the database is 31,700.

Dr Rosaidi went on to describe the national dissemination system, which comprised SMS, telephone hotlines and fax, website, TV crawlers, a Fixed Line Alert System (FLAS) and a network of 23 tsunami sirens for evacuation purposes in high risk areas. FLAS is used to disseminate warnings to fixed lines within a selectable distance from the coastline. Malaysia conducts public awareness and tsunami drills every year in selected high risk areas. In 2011, 5 public awareness and 4 tsunami drills have been conducted.

Dr Guimei Liu enquired what Malaysia had done to improve its warning time efficiency from 15 to 12 minutes. Dr Rosaidi replied that Malaysia had increased the number of seismic stations in its network and upgraded its Antelope processing software. A further upgrade of the Antelope software will be installed in 2012.

Dr Bautista explained that Philippines is prone to far field as well as near field tsunamis, for example from Alaska, Marianas and Chile. It relies on the PTWC and NWPTAC (Northwest Pacific Tsunami Advisory Center) to provide information on far field threats. Philippines is also able to monitor seismic stations and sea level gauges around the Pacific. The major problem is sources less than 1 hour travel time from the coastline, such as the Ryukyu trench. Philippines uses an Alert system, from 0 to 3: 0 indicates that there is no potential for a tsunami; Alert level 1 is for a potential but unconfirmed tsunami threat; Alert level 2 is for a confirmed but non-life threatening tsunami; and Alert level 3 is for a confirmed and potentially life threatening tsunami. For both, Alert

levels 2 and 3, a cancellation bulletin will also be required. The Alert bulletins are sent to the Office of Civil Defense (OCD), which is responsible for cascading information further to other response agencies and to community level. Both PHIVOLCS and OCD can go directly to the media with information and the OCD also have mass texting capability. NAMRIA and PAGASA (Philippine Atmospheric Geophysical and Astronomical Services Administration) also receive information from the PTWC and PAGASA also receives GTS messages, which they forward to PHIVOLCS.

For local tsunami, PHIVOLCS relies totally on its own seismic and sea level monitoring and data processing system. It is also promoting local community based warning systems but it is a major challenge to provide sufficient warning for lead times of less than 10 minutes.

6. AWARENESS AND RESPONSE

6.1 EMERGENCY MANAGEMENT SYSTEM IN THE SOUTH CHINA SEA

Mr Sallehuddin reported on general Disaster Management in Brunei Darussalam. He gave a brief summary of disasters in Brunei since the early 1960's, which included floods, strong winds and regional haze. He outlined the Disaster Management System, which comprises a National Disaster Council, a National Disaster Management Centre and multiple agencies involved in disaster operations. There are four levels of response: initial response, district level, national level; and national and regional level response. He described the network system in accordance with the level of response and how the different agencies coordinated during a response. He explained the disaster management capacity in Brunei, which included an Incident Management System to facilitate a multi-agency response during disaster operations. The system is implemented under an ASEAN-US cooperation project. Through this project, Brunei is developing SOP for national disasters incorporating the Incident Command Structure, which will hopefully be endorsed in 2012.

Dr Yuen provided a short overview of Hazard Mitigation and Emergency Management in China. Emergency management is quite complex because of the size of the country, involving national, provincial, city and county level agencies. In normal times, China undertakes exercises and takes actions to conduct risk assessment and promote public awareness. He described China's Marine Disaster Emergency Plan, which has four levels depending on the severity of the impact of the tsunami. Dr Yuen described China's response to the Japan 3/11 tsunami, which involved intense media interviews and reports to avoid public panic.

Dr Yuen went on to provide information on publicity and education in disaster prevention and mitigation, including the translation of IOC documentation into Chinese. A website for tsunami and other marine disasters has also been created to provide public access to basic information and documentation. China celebrates the 8 June the World Oceans Day and observes a Disaster Prevention and Mitigation Day on 12 May. China also organizes tsunami exercises and has participated in Pacific Wave exercises in 2006, 2008 and 2011. In PacWave11, an evacuation exercise was conducted in Guangdong province, which is exposed to a tsunami threat from the Manila trench.

Dr Rosaidi explained that in Malaysia emergency management is controlled by the National Security Council. There are national SOPs for earthquakes and tsunamis, with very clear procedures for which agencies need to respond during a disaster. The SOPs are almost complete and awaiting signature by the Prime Minister. Before issuing a tsunami warning, the Malaysian National Tsunami Early Warning Centre (MNTEWC) must get clearance from the National Security Council. For public evacuation, Prime Minister approval is required through the National Security Council, which operates 24/7. Once approval is given, warnings can be given to the public.

Dr Bautista explained that in Philippines, disaster management involves all levels of government, through Disaster Risk Reduction Councils, which operate at the nation, regional, provincial down to “barangay” level. The response depends on the extent of the disaster. If it is a massive disaster response can go to national level, or even the ASEAN Disaster Management Centre level. There is a new disaster management bill empowering the disaster management organisations to be proactive. The Office of Civil Defense is the executive arm of the National Disaster Risk Reduction Council. Recently there has been a move from response to preparedness with more emphasis on community involvement.

6.2 PUBLIC AWARENESS AND EDUCATION TOOLS FOR TSUNAMI IN THE SOUTH CHINA SEA

Mr Sallehudin explained that in Brunei Darussalam the National Disaster Management Centre (NDMC) priorities were developing the National Disaster Risk Reduction mechanism, enhancing the country’s disaster management capacity, and increasing public awareness. The NDMC is currently developing a Strategic National Action Plan for Disaster Risk Reduction, the elements of which include multi-sector national platform for DRR (Disaster Risk Reduction) and the AADMER Work Programme (ASEAN Agreement on Disaster Management and Emergency Response) and Hyogo Framework for Action priority areas. To increase public awareness, Brunei has programmes in Community Based Disaster Risk Management and has also conducted drawing competitions in conjunction with ASEAN Day for Disaster Management. Hazard mapping is conducted as part of the CBDRM (Community Based Disaster Risk Management) programme) down to village level. Mr Sallehudin provided some examples of CBDRM projects, including at a water village where there are concerns about high river runoff coinciding with high tides. Brunei plans to include tsunami in its hazard mapping in 2012−2013, as it is at risk from the Manila trench source zone.

Dr Punongbayan explained that in the Philippines, there are only about 20 people doing monitoring, hazard mapping and public information work. They have therefore devised a strategy to decentralise to the provinces where they conduct town watching at, at least, two pilot sites in each province, training the community leaders to replicate what they have learned. Phillipines plans to establish a Disaster Management Training Centre to train community leaders.

7. TSUNAMI WARNING AND MITIGATION SYSTEM OF THE SOUTH CHINA SEA

Dr Rosaidi introduced this agenda item by presenting an ASEAN Cooperation Project Proposal submitted by Indonesia to the ASEAN Sub-Committee on Meteorology and Geophysics (SCMG) at its Thirty-third meeting held in Brunei Darussalam, 18-20 October, 2011. He circulated a document proposal titled: “Review of Compulsory of the South China Sea Tsunami Warning System (SCS-TWS)” (attached as Annex III) and provided background information to the proposal. He explained that the SCMG meeting had considered requesting Japan to fund the proposal, but the SCMG chair had decided that Japan may not be able to support the project proposal due to the 11 March 2011 Great East Japan Earthquake and Tsunami. The SCMG chair decided to present Indonesia’s proposal to this meeting of the ICG/PTWS-WG-SCS in the context of a multi-lateral ASEAN-China project, funded by China. If the SCS-WG agrees to the proposal, SCMG will submit the project to the ASEAN Secretariat for approval.

Dr Rosaidi further explained that the project proposal was identical to China’s proposal (Annex II) but that the SCMG would like the South China Sea Tsunami Warning System project to be governed by the ASEAN Secretariat, and not under the ICG/PTWS.

Dr Wandono elaborated that Indonesia was proposing this project on behalf of the ASEAN SCMG.

Mr Yafeng Yang commented that China would like to see more cooperation between ASEAN and China under a multi-lateral framework. He noted that the South China Sea Working Group (SCS-WG) was established under the mandate of the ICG/PTWS and enquired if the ASEAN SCMG proposal was for a separate project.

Mr Elliott explained that the ICG/PTWS had the mandate to develop and operate tsunami warning systems in the Pacific region. He suggested that the SCS-WG should continue under its Terms of Reference to look into the issue of developing and establishing tsunami warning capability in the region in cooperation with other organizations, such as ASEAN. In that context, ASEAN could be included in the process as an observer member to the SCS-WG.

Mr Elliott further explained that with its mandate, the ICG/PTWS had the responsibility for ensuring that its Member States were protected by a warning system and also had responsibility for capacity building, training, facilitating the free and open exchange of data. The ASEAN Member States of the South China Sea are also Member States of the IOC and the ICG/PTWS, and that this is the intergovernmental process that should be followed. The ASEAN SCMG can participate in this process through its Member States or as a recognized observer to the ICG/PTWS.

Mr Koizumi agreed that the establishment of a SCS-TWS should be discussed under the framework of the ICG/PTWS.

Mr Yamamoto emphasized that the SCS-WG needed to have a clear target of what it wanted to achieve in terms of what it wanted to provide to the Member States.

Dr Rosaidi felt that it would be easier to obtain support from ASEAN Member States if the project was conducted under the ASEAN umbrella. He concluded that the consensus of the meeting was that the development of a SCS-TWS should continue under the ICG/PTWS framework and that he would report this back to the ASEAN Secretariat.

Mr Elliott noted that the project proposal from the ASEAN SCMG was technically identical to the proposal from China. He therefore recommended that the SCS-WG should continue to consider the proposal from China and be guided by its Terms of Reference. The ASEAN SCMG proposal had not been circulated before the meeting and would need to be considered by the ICG/PTWS chair, officers and Steering Committee. If ASEAN would like to have observer status in the SCS-WG, this can be recommended to the PTWS Steering Committee.

Dr Bautista commented that the ASEAN SCMG should follow the ICG/PTWS process and do not try to establish a separate system for the South China Sea.

Dr Rosaidi reiterated that the SCMG agreed with the technical proposal from China and all the Member States supported it. The only issue is that they want it to be an ASEAN-China project under the ASEAN Secretariat. In this way, it would be easier to get funding and commitment from the Member States.

Mr Yafeng Yang noted that the ICG/PTWS has the mandate for the establishment of tsunami warning systems. IOC/WESTPAC also has priorities in capacity building. He suggested that the ASEAN countries become more involved in these activities and participate in the ICG and WESTPAC.

Mr Koizumi commented that technical discussions should be held by the SCS-WG but that policy issue should be discussed under the framework of the ICG/PTWS. Therefore, this should be discussed at the next Steering Committee meeting.

Mr Yafeng Yang confirmed that China had funding for establishing a sub-regional system but this would be based on China's proposal. These funds were available through SOA, and if an ASEAN-China proposal were to be considered then other ministries would be involved and the SOA funding would not be available.

Dr Rosaidi suggested that Malaysia (as a representative of ASEAN) and China work together on the proposal after the meeting and submit to the SCMG to go to the ASEAN Secretariat to obtain funding.

Mr Elliott said that the SCS-WG needed to consider the proposal and then it had to go to the ICG as a recommendation, following the governance process.

Mr Yafeng suggested restricting the discussion to the technical proposal only. We should make some decisions at this Working Group meeting and take those to the ICG and IOC so that we know what we can do in five or six years' time. In the future, we can have a discussion between China and all other ASEAN countries on a possible multi-lateral project, but the first thing is to complete the work plan.

Dr Yu introduced the proposal from NMEFC/SOA for a Tsunami Warning and Mitigation System for the South China Sea, which had been circulated to the delegates in hard copy. He commented that the South China Sea Tsunami Warning and Mitigation System would be designed as a sub-regional system under the framework of the ICG/PTWS. The system would be based on resources and voluntary information from the countries involved; and would be supported, maintained, managed and operated by all the countries of the region.

The sub-systems would include: an earthquake monitoring system; a sea level monitoring system; a platform for shared information; a tsunami warning centre; and a hazard mitigation and emergency management system.

Dr Yu went on to explain the Standard Operating Procedures of the system, from earthquake detection through warning dissemination to the Member State National Tsunami Warning Centres. Then, he described each of the system components. In particular, he suggested that 5 tsunameter buoys should be deployed: 2 in the northern and central South China Sea, and 1 each in the Sulu Sea, Luzon Strait and Celebes Sea.

The information sharing platform would provide a mechanism for sharing data and information within the Member States. The Tsunami Warning Centre would serve to provide alerts of seismic and tsunami activities, disseminate tsunami warnings and other products, and to provide hazard mitigation education and training.

Dr Yu described the requirements for the Tsunami Warning Centre, including staffing, equipment and maintenance, communications and financial resources, and stated that NMEFC/SOA would be glad to contribute to the establishment of the South China Sea Tsunami Warning Centre. Financial support would mainly be from the country where the warning centre is established, but other countries would be expected to contribute.

Dr Yu concluded by outlining a five year implementation plan, starting with one or two additional SCS-WG meetings to further discuss the proposal and refine the implementation plan. This plan would be then submitted to the ICG/PTWS for consideration.

Following the presentation from China, the Chair opened the floor for discussion.

Dr Bautista suggested that it should be explicitly stated that each member country should be expected to second operational staff to the regional tsunami warning centre, similar to the

RIMES model. In this way, the centre would be seen to be a cooperative effort and would be more sustainable.

Dr Rosaidi enquired if the regional warning centre staff would be the same as the NTWC staff. China responded that most of the staff would be the same, but foreign staff could also be accommodated.

The proposal from China was then discussed section by section by the Working Group. The edited document, with comments, is attached as Annex II. It was agreed that the document should be circulated to the Member States to collect comments and that the next meeting of the Working Group would review and consider comments received in refining the proposal for submission to the ICG/PTWS.

Mr Elliott suggested that the SCS-WG should compile an inventory of seismic and sea level monitoring equipment available in the Member States before its next meeting.

Mr Koizumi commented that the decision to have one or several regional centres should be discussed at the next SCS-WG meeting, as all Member States would need to be consulted on this issue.

Mr Yafeng Yang agreed that the Working Group needed to move forward quickly and if it was not possible to decide on the number of regional centres now, then it would be best to agree on establishing one regional centre first with other centres developed in the future, if necessary. The work plan is not fixed and can be adapted later.

Dr Rosaidi asked the delegates if they agreed that there should be one regional centre for the South China Sea, or a network. This question was left open, to be decided by the Member States at the next meeting of the Working Group.

Mr Koizumi clarified that PTWC is the regional centre for the whole of the Pacific and that NWPTAC (Northwest Pacific Tsunami Advisory Center) and WCATWC (West Coast and Alaska Tsunami Warning Center) are sub-regional centres. Any centre in the South China Sea region would therefore be sub-regional and his personal preference was that there should be just one.

Dr Rosaidi concluded the discussion by asking China to enhance its proposal to provide details of the proposed regional warning centre outputs and products before the next meeting of the Working Group.

The Secretariat will circulate the proposal from China with the meeting report and will circulate any revisions prior to the next Working Group meeting. Mr Elliott suggested that in order to expedite the process, as much of the review work as possible should be done before the next meeting, otherwise discussions would become protracted and decisions would be delayed.

Dr Rosaidi noted that the SCS-WG had other activities that needed to be discussed under this agenda item. He raised the issue of conducting a seismotectonic study of the South China Sea region to assess the tsunami hazard. Dr Bautista recognized that this is a major task and that it might be more appropriate for an academic research institution to conduct this. Dr Rosaidi commented that Malaysia's opinion was that a regional seismotectonic study would be of benefit to the region.

Mr Koizumi noted that ICG/PTWS WG1 on Risk Assessment and Reduction had recommended that research should be done on the tsunami hazard of the entire Pacific region, including the South China Sea.

Dr Punongbayan noted that the research should be used to inform hazard awareness and mitigation, determination of inundation zones and evacuation routes, so it was an important part of the implementation plan.

Mr Koizumi suggested establishing a Task Team (TT) to conduct research into the tsunami hazard of the region. This research could be conducted in parallel to the development of the tsunami warning centre as it was unlikely to have a significant impact on the warning products.

Mr Yafeng Yang suggested that another Task Team should be established comprising experts who can provide advice to the Working Group on the implementation of the Regional Tsunami Warning Centre.

In summary, the Working Group concluded that two Task Teams should be created:

Task Team 1: to undertake a seismotectonic study of the South China Sea region.

Task Team 2: to advise the WG on the establishment of a Regional Tsunami Warning Centre.

Mr Elliott noted that the Working Group can only make a recommendation to the ICG to establish Task Teams. He advised that if the Working Group can accomplish the tasks within its own membership and Terms of Reference, there is no need to set up a separate Task Team.

Mr Koizumi suggested that the recommendations to establish the Task Teams should be made to the ICG/PTWS for consideration at its next session and in the meantime the SCS-WG can continue to work on this, and invite experts to its meetings to provide specialist advice, if necessary. The Terms of Reference for the Task Teams can be developed at the next SCS-WG meeting for submission to the next session of the ICG/PTWS.

Mr Elliott informed the group of the experience of the ICG/IOTWS in establishing a Task Team for the Regional Tsunami Service Provider (RTSP) network, which had taken 5−6 years to complete its work. This timescale is comparable to the implementation schedule for the SCS-TWC and he felt it was realistic. He suggested that the SCS-WG requests ICG/PTWS Working Group 1 to conduct the seismotectonic study as Regional Working Groups do not need to undertake technical studies if there is already a technical Working Group whose Terms of Reference cover this.

8. NEXT MEETING

Dr Rosaidi announced that Malaysia would be prepared to host the next meeting of the SCS-WG. It will be able to provide the meeting venue, including lunches, etc., but not travel support, accommodation or subsistence for participants.

The target date for the meeting will be September 2012 subject to checking for possible conflicts with other international meetings taking place around that time.

9. ANY OTHER BUSINESS

Dr Yu announced that China would be organising a training workshop on tsunami modelling in March or April 2012 under the auspices of IOC Regional Secretariat for the Sub-Commission for the Western Pacific (WESTPAC). He announced that financial support for some participants would be available. The SCS-WG would be invited to participate in the workshop. As well as during the training, there would be a discussion about different model types.

10. CLOSURE OF THE MEETING

Dr Rosaidi closed the meeting at 12:30 p.m. and thanked the Government of China for hosting the meeting and providing financial support to the participants.

ANNEX I

AGENDA

1. OPENING

2. ORGANIZATION OF THE SESSION

2.1 ADOPTION OF AGENDA

2.2 DESIGNATION OF THE RAPPORTEUR

2.3 CONDUCT OF THE SESSION, TIMETABLE AND DOCUMENTATION

3. PACWAVE 11 RESULTS IN THE SOUTH CHINA SEA REGION

3.1 OVERVIEW OF PACWAVE 11 RESULTS

3.2 PACWAVE 11 RESULTS IN THE SOUTH CHINA SEA AND LESSONS LEARNT

4. RISK ASSESSMENT AND REDUCTION

4.1 TSUNAMI HAZARD IN THE SOUTH CHINA SEA

4.2 HAZARD MITIGATION IN THE SOUTH CHINA SEA

5. DETECTION, WARNING AND DISSEMINATION

5.1 EARTHQUAKE MONITORING SYSTEM

5.2 SEA LEVEL MONITORING SYSTEM

5.3 INFORMATION SHARING PLATFORM

5.4 TSUNAMI WARNING CENTER

6. AWARENESS AND RESPONSE

6.1 EMERGENCY MANAGEMENT SYSTEMS IN THE SOUTH CHINA SEA

6.2 PUBLIC AWARENESS AND EDUCATION TOOLS FOR TSUNAMI IN THE SOUTH CHINA SEA

7. TSUNAMI WARNING AND MITIGATION SYSTEM OF SOUTH CHINA SEA

8. NEXT MEETING

9. ANY OTHER BUSINESS

10. CLOSE OF THE MEETING

ANNEX II

AN OUTLOOK OF TSUNAMI WARNING AND MITIGATION SYSTEM OF SOUTH CHINA SEA

National Marine Environmental Forecasting Centre

2nd December, 2011

1. Background

The areas of responsibility (AOR) for tsunami warning specified by Pacific Tsunami Warning and Mitigation System in the South China Sea region include South China Sea, Sulu Sea and Celebes Sea. A total of nine countries are in the South China Sea region, namely, Brunei, Cambodia, China, Indonesia, Malaysia, the Philippines, Singapore, Thailand, Vietnam (Figure1). According to the statistics of NGDC/NOAA, major earthquake sources of the South China Sea region are Taiwan Island, the Philippines and Indonesia Islands, and a small part of volcanoes also locate in this region (Figure 2). Since tsunami is mainly triggered by earthquake and volcano activity, the distribution of historical tsunami events are consistent with the earthquake and volcano zones in the South China Sea region (Figure 3).

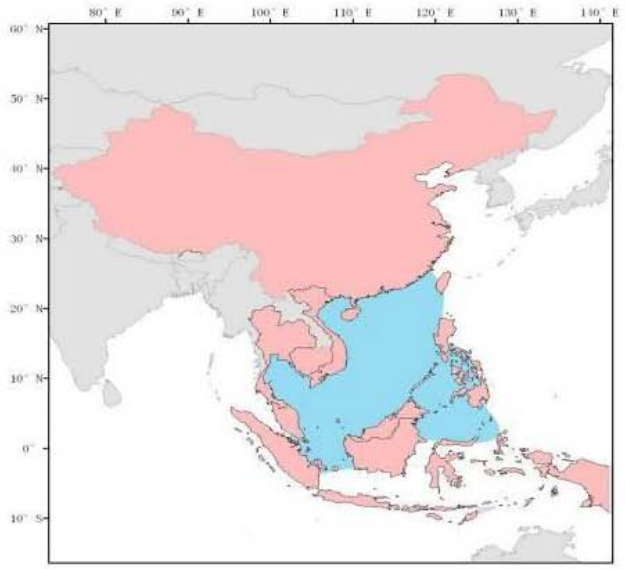

Figure 1. Countries in the South China Sea region
(Red for the South China Sea countries, blue for the area of responsibility for tsunami warning)

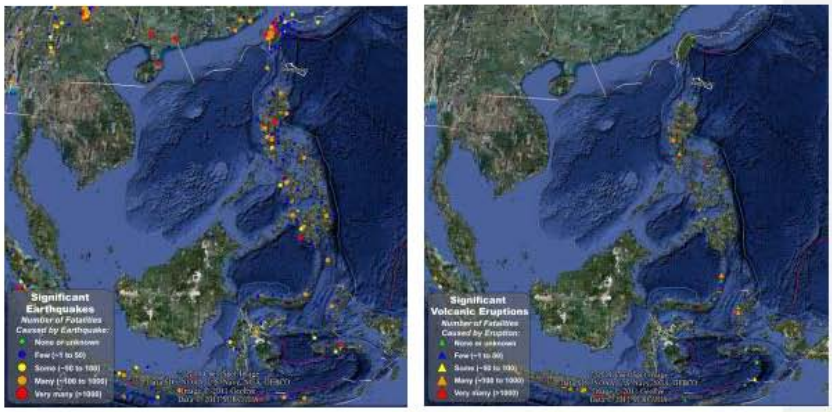

Figure 2. Historical earthquake epicenters distribution and fatalities since 2150 BC in the South China Sea region (Left) and Historical volcanic origins distribution and fatalities in the South China Sea region since 4350 BC (Right)

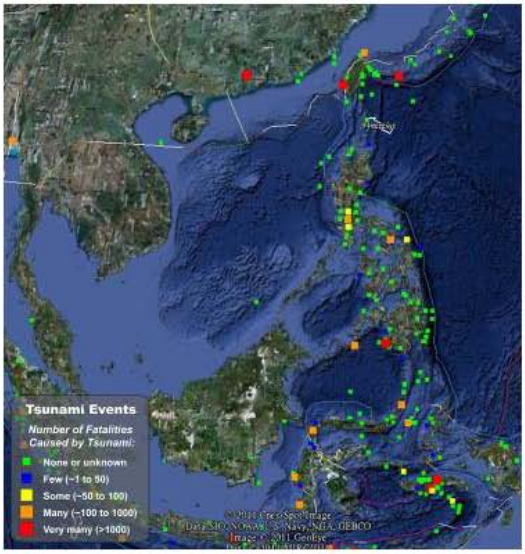

Figure 3. Historical tsunami sources distribution in the South China Sea region since 2000 BC.

All waters in the South China Sea region are under the threat of tsunamis. To name a few, the potential tsunami source in the South China Sea is Manila Trench, in the Sulu Sea in the southern Philippines, and in the Celebes Sea are the southern Philippines and Indonesia islands.

Being a concern in the international tsunami warning and mitigation area, the regional South China Sea tsunami warning system is not yet available. In realistic sense, a regional tsunami warning and mitigation system covering all South China Sea countries needs constructing urgently, so as to improve the cooperation and communication, and to develop the capability of tsunami detecting, warning and mitigation.

Currently, PTWC (based in US)~~, WC/ATWC (based in Alaska, US)~~

and NWPTAC (based in JMA, Japan) provide ~~temporary~~ interim tsunami warning services to the South China Sea region (Figure 4). In May 2008, National Marine Environmental Forecasting Center (NMEFC, based in Beijing, China) proposed the construction of the South China Sea tsunami warning system in the 7th IOC/WESTPAC conference, and this proposal was submitted to ICG/PTWS by the chairman of WESTPAC on request of the conference. In June 2008, the 41st conference of IOC Executive ~~Committee~~ Council approved the resolution and encouraged all the countries concerned in the South China Sea to establish a regional tsunami warning and hazard mitigation system under the framework of ICG/PTWS. In the 23rd conference of ICG/PTWS in 2009, South China Sea Region Working Group was set up to facilitate the buildup of the system in this region. In May, 2011, 'An outlook of tsunami warning and mitigation system of South China Sea' as the fundamental document proposed by China was discussed in the 24th meeting of ICG/PTWS. The conference agreed to establish the regional South China Sea tsunami warning system, and requested ICG/PTWS secretariat to widely distribute the proposal and encouraged countries concerned to collaborate in the system buildup. The 26th Assembly of IOC approved the 24th conference report and recommendations. (check resolutions [could be identified] for major part of the paragraph)

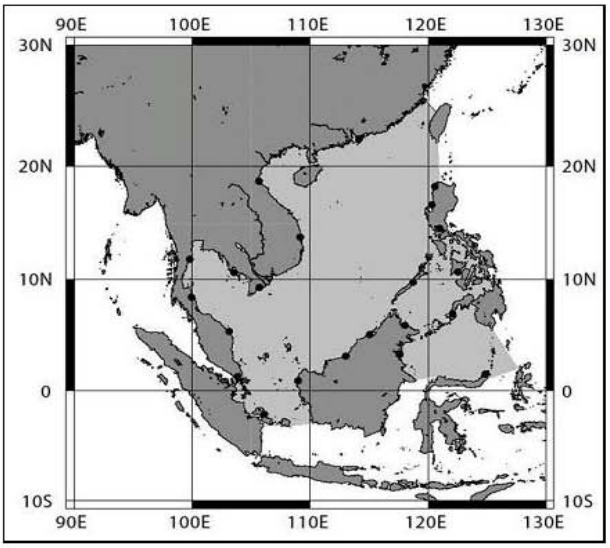

Figure 4. PTWS defined South China Sea tsunami warning AOR. (light gray region in the figure)

Comment [U1]: The working language and tool should be English

2. System Components---

The South China Sea Tsunami Warning System will be installed as a sub-regional tsunami warning and hazard mitigation system under the framework of ICG/PTWS. The system is based on resources and voluntary information from countries concerned. It will be supported, maintained, managed and operated by all countries of this region. The South China Sea tsunami warning system is made up of five sub-systems, Earthquake Monitoring System, Sea Level Monitoring System, Information Sharing Platform, Tsunami Warning Center, and Hazard Mitigation & Emergency Management System.

2.1 Earthquake Monitoring System

Initial ~~seismic~~ tsunami warnings are usually triggered by earthquake information. The SCSTWC should develop a robust seismic network. The earthquake monitoring ~~based on data from networks of seismic gauges are subsequently refined by the detection of tsunami generated changes in sea level, measured by the coastal tide gauges and buoys.~~

~~The earthquake monitoring~~ system will consist of shared information from national~~local~~ earthquake monitoring networks and GSN (Figure 5). The establishment of South China Sea region earthquake monitoring system should take full advantage of the existing seismic gauges of all the countries concerned. ~~In the meantime, according to tsunami warning need, a~~Additional seismic gauges may be recommended by the South China Sea countries ~~related countries~~or ICG/PTWS. (to decide how many seismic stations in need; and what to do within 10 minutes of earthquake before PTWC information comes; role of sub-regional system, esp. there is time difference/delay from PTWC;)

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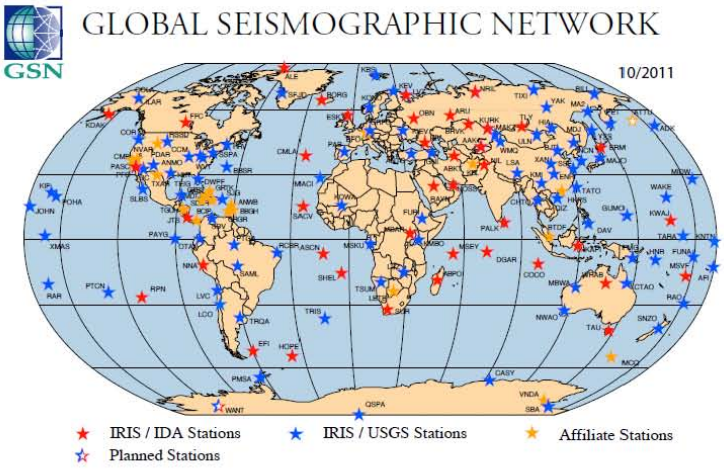

Figure 5. Distribution of GSN stations.

2.2 Sea Level Monitoring System

Sea level monitoring system is formed by tsunami buoy monitoring networks and tide gauge station networks in the South China Sea region.

2.2.1 Tsunami Buoy Monitoring

Tsunami buoy is one of the efficient tools to detect real-time tsunami wave and determine early tsunami warning. Buoys normally spread close to the tsunami sources, and are used to detect real-time abnormal oscillation on the sea surface.

Once tsunami wave is detected by tsunami buoy, its information will be sent to the tsunami warning center. After the data processed and

analyzed, issuing a tsunami warning or information statement is followed. If tsunami wave is identified, quantitative tsunami warning information will be successively released through observation data assimilation. If tsunami wave is not detected, further tsunami warning information will not be released. Tsunami buoy observation data can greatly improve forecast accuracy.

According to the potential tsunami sources in the South China Sea, five tsunami buoys are suggested (Figure 6). Two tsunami buoys are planted in northern and central South China Sea, one in deep water zone of central Sulu Sea, one in eastern Luzon Strait and one in deep water zone of central Celebes Sea (numbers and locations of tsunami buoys can be further discussed and modified).

Figure 6. Layout of the running and proposed tsunami buoys in the South China Sea. (Red for running buoy and white for proposed buoy)

2.2.2 Tide Gauge Monitoring

According to the potential tsunami sources in the South China Sea region, it is proposed to fully utilize existing tide gauge stations, and to build a number of coastal tide gauge stations at South China Sea, Sulu Sea and Celebes Sea, where in need. To be specific, coastal tide gauge stations at Philippines, China, Vietnam, Malaysia, Brunei, Thailand and Singapore are used to detect South China Sea tsunamis, tide gauge stations at the southern Philippines and Malaysia are used to detect Sulu Sea tsunamis, and the southern Philippines, Malaysia and Indonesia should take the responsibility of detecting Celebes Sea tsunamis with their tide stations.

2.3 Information Sharing Platform

The function of the information sharing platform is to collect all the South China Sea countries seismic and tsunami observation data, and provide data sharing and dissemination service.

Platform of information sharing will be established, operated and maintained at South China Sea Region Tsunami Warning Center. Each country will provide voluntary seismic and tsunami observation data to the platform. The routines and equipments connecting to the platform of shared information of each country should be constructed and maintained individually.

South China Sea Region Tsunami Warning Center should include internet and GTS, so as to timely collect, summarize and analyze regional and global earthquake and tsunami observation data with related information for the warning and evaluation of tsunami.

Tsunami warning center should, in the meantime, timely collect and summarize issued earthquake and tsunami real-time information from global related organizations, such as USGS/NEIC, PTWC, NWPTAC, WC/ATWC and regional tsunami warning centers affiliated to UNESCO. The information sharing platform will send the information to the tsunami warning centers of South China Sea countries (Figure 7).

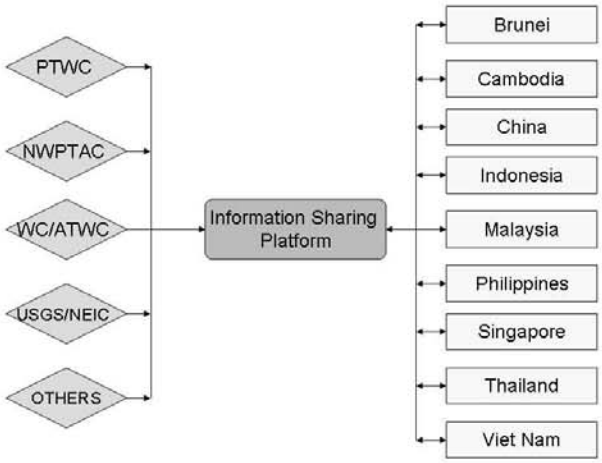

Figure 7. Information flow chart of the platform.

2.4 Tsunami Warning Center

2.4.1 Function

South China Sea Region Tsunami Warning Center has three key functions, tsunami warning product, tsunami warning product dissemination, and hazard mitigation education and training.

1) Tsunami warning product

According to the GSN and South China Sea countries seismic observation data, real-time observation information of tsunami buoys and coastal tide gauge stations, the warning platform will calculate tsunami wave arrival time, maximum tsunami wave height and coast dangerous level automatically or by numerical forecasting of man-machine interaction platform with comprehensive analysis methods (Figure 8).

In the long run, storm surge and wave forecasts may also be included to meet more needs of marine hazard prevention and mitigation of South China Sea countries, and consequently to improve the capacity for preventing various marine hazards in the region.

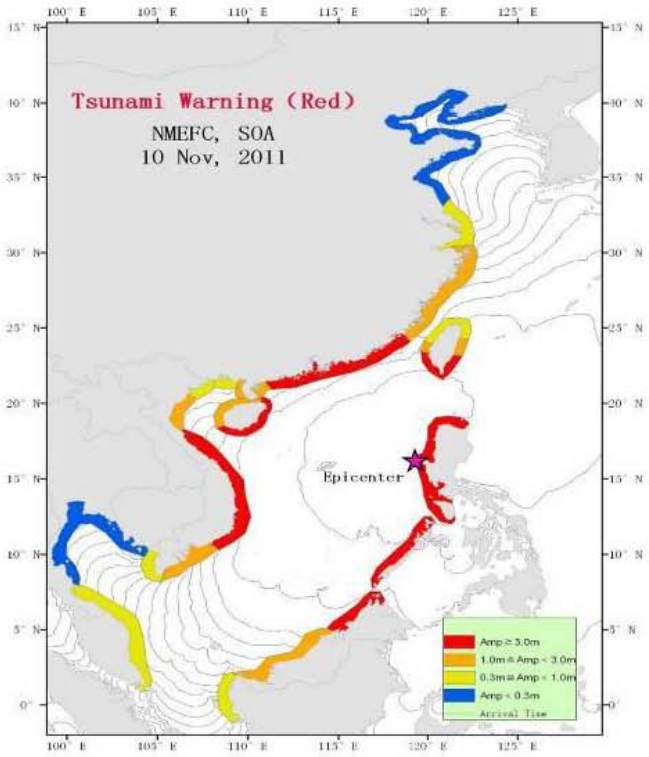

Figure 8. Tsunami warning message (PacWave11).

2) Tsunami warning product dissemination

Through reliable information communication, tsunami warning products are disseminated to the tsunami warning centers of South China Sea countries. In order to improve efficiency, dissemination process should apply advanced and automatic information technology and tools, to the most extent save time. To ensure the tsunami information disseminated effectively and smoothly, diversified dissemination methods should be

used and regular system tests should be considered.

Products dissemination system should, at least, include GTS, telephone and fax, Internet, E-mail and SMS:

- Deliver tsunami warning products to individual national institutional contacts through GTS
- Deliver tsunami warning products to individual national and institutional contacts through SMS and fax
- Release real-time tsunami warning information on the warning center websites
- Provide subscribed e-mail service to the public

3) Hazard mitigation education and training

Provide technical trainings, such as tsunami warning, tsunami hazard risk assessment, tsunami evacuation mapping and tsunami hazard emergency management to South China Sea tsunami warning institutes. Regular tsunami exercises, protection and rescue education should be organized.

2.4.2 Requirements

A tsunami warning center's operation requires office building(s), technical experts, hardware and software facilities, standardized operation procedure, reliable communication, and sustainable financial support. In principle, all the South China Sea countries should deliberate the construction and operation of the tsunami warning center, followed by final decision and approval of IOC/UNESCO. The construction content

includes the following:

1) Location Requirement

Permanent office[1], budget, and personnel will be negotiated and decided by all members of South China Sea Region. In general, it is suggested the warning center be based in one single country which plays a dual role as NTWC for the country in which it resides, and assigns and covers the majority of staff and budget. Other members are expected to support operation of the center in human resources and finance.

China is willing to commit NMEFC/SOA to taking the charge and operating the South China Sea Tsunami Warning Center.

2) Staff Requirement

Professional tsunami warning staff group is essential to manage an efficient warning center. To meet its full mission, a tsunami warning center requires several critical positions to ensure that all necessary functions could be accomplished. According to the experience at PTWC and WC/ATWC (tsunami warning center reference guide[1]), a tsunami warning center should at least have a team of 25 staff to be effective, including warning center directors, administrative assistants, scientific officers, operational watch standers and technical supporting officers. Operational staff is primarily provided by the warning center from the country where it resides. Experts from all South China Sea

[1] U.S. Indian Ocean Tsunami Warning System Program, 2007. *Tsunami Warning Center Reference Guide*. October 2007 ed. Printed in Bangkok, Thailand.

countries are also strongly expected to contribute.

3) Equipment and Maintenance

A tsunami warning center, at the minimum, consists of high performance computers, servers, work stations, necessary storage devices, communication network equipments, tsunami warning producing and disseminating platforms (include hardware and software). Critical equipments and facilities for tsunami warning should have multiple backups, and regular maintenance and repair are recommended so that staff can meet normal operational workloads.

4) Communication Requirement

Communication hardware and software are also crucial for a tsunami warning center. Tsunami warning center requires communications that can receive seismic and tide gauge observation data, contact with other related tsunami institutes, and disseminate tsunami warning products to the South China Sea member countries. Communications should be tested frequently so as to ensure continuity, and identify and solve the problems as soon as founded.

5) Documentation and Standards

In order to guarantee the responsibility and operation procedures, IOC/UNESCO suggested that a regional tsunami warning center should at least prepare documentation and regulation as follows,

- Operation Manual: This document elaborates details of all the

operational performance procedures and standards needed for tsunami warning center duty officers to follow on production of warning.

- Operation Troubleshooting Manual: This document describes the problems and solutions for a tsunami operation system frequently meets, i.e. hardware or software computer system poor performance, communication disruption.
- User Guide: This document includes essential knowledge on tsunami warning, format, content and proper concept instructions of tsunami warning information, and preventive measures that government and the public may take.
- List of Tsunami Warning Center Personnel: This document lists contact information of chief officers, operation officers and technical support officers.
- Tsunami Emergency Response Plan: Tsunami hazard emergency response standards and management procedure.

6) Capability of a Regional Tsunami Warning Center

According to PTWC operation experience, a regional tsunami warning center should have capabilities to perform the following functions:

- Operate on a 24/7 basis
- Have access to seismic and sea-level data in real time
- Fast analysis on seismic parameters (location, magnitude, depth)

- Able to determine countries may be affected and their impact extents within tsunami AOR
- Revise tsunami prediction timely in light of additional seismic and sea-level data
- Provide standardized format tsunami warning products
- Provide in-time tsunami arrival time products through GTS etc.
- Coordinate with other regional tsunami warning centers to provide one or more backup services in the events of a major communication failure etc.
- Coordinate with other affected member countries in issuing products if time permits

7) Financial Source

Financial support is mainly from the country where the regional tsunami warning center resides, however, other member countries are strongly expected to contribute.

2.5 Hazard Mitigation and Emergency Management System

Hazard mitigation and emergency management system is not a single operating system, but a crucial sector section of the South China Sea regional tsunami and hazard mitigation system chain. Hazard mitigation and emergency management of member countries corresponding hazard

mitigation and emergency management departments will be responsible for fulfillment of this section functions.

Hazard mitigation and emergency management system plays a critical role in a tsunami warning system. Its primary function is to provide public evacuation, hazard rescuing guidance and, hazard prevention and mitigation education and training.

Once there is tsunami alert, all the participants in the hazard mitigation and emergency management system should cooperate with each other for the long-term time highest level preparedness of tsunami emergency. Hazard mitigation and emergency management system associates tsunami warning center officers, emergency management, tsunami scientists, other governmental institutions, non-government organizations and private sector agencies via a certain mechanism. Life rescue and property protection related policies, arrangements and projects are implemented. As tsunami is low ~~frequent~~ frequency event, it is strongly recommended that tsunami system embedded into multi-hazard system to achieve its sustainability.

Governmental institutions and private groups in the hazard mitigation and emergency management system alert public ~~through~~ by providing tsunami warning center products to them, and help people in danger ~~transfor~~ move to safer places.

Objectives and focus of hazard mitigation and emergency

management system should is to educate the public and other related people about tsunami prevention and safe keeping, as well as to improve tsunami warning program through communication and cooperation with public events, media workshops and public schools. Spokesmen are needed in the hazard mitigation and emergency management system during actual tsunami event to coordinate with mass media.

3. Implementation Plan

In the coming 5 years, the South China Sea Tsunami Warning and Mitigation System will be preliminarily established and in operational service. Detailed implementation plan is listed below:

2012

- Organize one or two South China Sea regional working group meetings to further discuss and deliberate the plan as an agreement
- Submit the implement plan to ICG/PTWS
- Organize a training workshop for South China Sea regional tsunami warning

2013

- Implementation Plan will be submitted to the 25th ICG/PTWS for further discussion and approval

- Organize a training workshop for South China Sea regional tsunami warning

2014

- Set up data sharing platform
- Plant new earthquake stations, buoys and tidal gauges by members, so as to share monitored information of earthquake and tsunami
- Establish South China Sea Tsunami Warning Center including hardware and software
- Staff in South China Sea Tsunami Warning and Mitigation System attend training courses in ITIC or PTWC

2015

- Plant new earthquake stations, buoys and tidal gauges by members, so as to share monitored information of earthquake and tsunami
- Establish South China Sea Tsunami Warning Center (continued)
- Report progress of South China Sea Tsunami Warning and Mitigation System to 26th ICG/PTWS meeting
- Preliminarily complete the system and in test runs, and to provide tsunami warning products to members

2016

- The South China Sea Tsunami Warning and Mitigation System will be in full operational service to deliver tsunami products
- Formulate procedures and standards for service of the tsunami warning center
- Organize tsunami exercise for members in the region to test the performance of the South China Sea Tsunami Warning and Mitigation System

ANNEX III

ASIAN COOPERATION PROJECT PROPOSAL
REVIEW OF COMPULSORY OF SOUTH CHINA SEA
TSUNAMI WARNING SYSTEM (SCS-TWS)

ASEAN Cooperation Project Proposal

REVIEW OF COMPULSORY OF THE SOUTH CHINA SEA TSUNAMI WARNING SYSTEM (SCS-TWS)

INDONESIA DELEGATION

1. Problem and back ground

The South China Sea region lies in the Pacific Ring of Fire and it occupies South China Sea(SCS), Sulu Sea, Celebes Sea and Manila trench, where tsunamis sources are occurred. If the great tsunamis in this area occurred will attacked to the 9 ASEAN members countries which face to face or bordering with the SCS region. Present status of Tsunami Warning System in SCS (SCS-TWS) is not existed yet, therefore need to build of SCS-TEWS is very important in this regions.

Indonesia support the China's proposal in the Regional Working Group on Tsunami Warning and Mitigation in the South China Sea region ICG/PTWS-XXIV Sessional Meeting of May 26, 2011 in Beijing, China. Indonesia, Thailand and Malaysia as ASEAN members countries had grouped to the Indian Ocean Wave (IOW) together with India and Australia. Indonesia consider to need a cooperation between ASEAN members countries to build TEWS around SCS. The SCS-TEWS is very important to complete of other Tsunamis Warning such as PTWS, WC/ATWC and NWPTAC. Indonesia delegation propose one big problem and important to build the SCS-TEWS, to support China's proposal several month ago.

All region of ASEAN members countries which have borders with SCS will be affected of tsunami impact if the sources of tsunami lies in the Sulu Sea, Celebes Sea or Manila Trench. Historically, there were several danger tsunamis in this region. According of NOAA document that 100 tsunamis totally occurred in this regions. For example, the fact of great tsunami caused by earthquake magnitude 8.1 hit Moro Gulf in 1976.

Indonesia, Thailand and Malaysia has joint cooperation on IOTEWS together with Australia and India to build of Regional Tsunami Service Provider(RTSP) . This cooperation to share of information of the great tsunami sources in Indian ocean. For

example, the great tsunami 2004 in Sumatera devastated several countries coastal along Indian ocean until the south Africa region.

Based on the above statement, it is needed a multilateral cooperation for mitigation of tsunami impact for ASEAN member countries in SCS region. Development of SCS-TEWS need China's supporting. China has much of earthquake monitoring stations by CEA responsible and two tsunami monitoring buoys in the SCS by SOA . Beside that China has good experience contribute on development of Indonesia Tsunami warning System (InaTEWS).

B. Problem Analysis and Justification

We explained that based on historical data by NOAA, around 100 tsunamis occurred and affected the countries which has border with SCS. The great tsunami caused by earthquake magnitude 8.1 hit Moro Gulf of Celebes Sea in 1976. Beside that using the several tsunamis modeling, that if the tsunamiearthquake occurred in Manila trench or Sulu sea or Celebes sea, tsunami can attack to ASEAN member countries around SCS. For example, if the source of great tsunami lies in Manila trench, tsunami will reach to the coastal in Vietnam around 4-5 hours and other coastal ASEAN member countries around 5-6 hours.

SCS-TEWS can be used to share information of tsunami travel time, tsunami data etc among ASEAN member countries. ASEAN member countries can build NTWCs and to make of such Regional Tsunami Service Provider (RTSP). Referring on the IOW 2011 structure, there make some RTSPs and NTWCs. RTSP can intent communicate with other RTSPs and NTWCs. NTWC can cooperate to National Disaster Management, Local Government, Media, NGO etc.

Tectonically, regional of ASEAN Member countries bordering of the SCS has high potential attacking of tsunami from earthquake sources from SCS areas (Sulu Sea, Celebes Sea and Manila trench). Therefore, Indonesia consider need to execute of cooperation to build SCS-TWS related with mitigation of tsunami impact . Based on of some tsunami travel time modeling analysis, 4-7 hours tsunami will attack of some ASEAN states coastal areas. Indonesia propose for all of the Countries bordering with the

SCS to support this project. This project related with ASEAN Member countries consist of Malaysia, Vietnam, Thailand, Brunei, Filipina, Cambodia, Filipina, and Indonesia.

This project is multi years, it needs between 5-6 years, similar with China's proposal. Therefore the Governments of ASEAN members must be responsible and to execute this project. All of the ASEAN members countries to participate to build of SCS-TWS like China's proposal in the Regional Working Group. On that proposal, China will support financial and technician.

The sustainability this project must be kept by the governments. In this case, the project has to be made completed schedule and it is needed the commitment among ASEAN member Countries.

2. Possible solutions.

Such as explained above that tectonically of SCS region is prone of tsunamiearthquake area especially tsunami sources area from Sulu Sea, Celebes Sea and Manila trench. There is needed TWS in SCS region for mitigating of tsunami impact. Therefore SCS-TWS is become of the main necessary. Before SCS-TWS exist in this region, perhaps there is better if every ASEAN Members countries bordering with SCS to strength of NTWC operation. NTCs can execute a better coordination with related inside institutions in their countries.

3. Objective and Success criteria

The objective of this project is a Tsunami Warning System in South China Sea(SCS TWS). SCS TWS is important for the ASEAN Member States bordering with SCS. Historically a lot of tsunami attacked and has seriously impact in this region. If the SCS TWS is built, every countries bordering with SCS be able to share of information and data of tsunami. This project will successes if this project is supported by all of ASEAN Member Countries. If the tsunami sources along Manila trench and tsunami move to the west, based on the travel time modeling the tsunami will reach in Vietnam, eastern Thailand coastal and Brunei around 4-5 hours. Therefore it still has enough time to give data and information to other countries bordering with SCS.

If RTSPs(2-3 RTSPs) Development in this region is better for ASEAN member states bordering of SCS. Each RTSP can make coordination with other RTSPs and NTWC. NTWC can disseminate information to the related inside institution of disaster mitigation of each country.

4. Output.

As a product of this project is quick information of tsunami warning in SCS region. This information is very important for ASEAN member countries bordering SCS. This information can be developed not only tsunami travel time but information of run up high and inundation. Dissemination of tsunami information can through SMS, fax, email, GTS ,internet, Cabels, satellite etc. Each RTSPs or NTWCs can publish of Bulletin which contain of tsunami warning.

5. Indicative Work Plan

The South China Sea Tsunami Warning System is expected to be set up in 5 years. Details of plan are listed table below :

Content	1st Year	2nd Year	3nd Year	4th Year	5th Year
Draft Plan					
Implementation of Plan					
Earthquake Monitoring System					
Sea level monitoring System					
Platform of Shared information					
Tsunami Warning Center					
Hazard Mitigation and Emergency management System					

The 1st Year :

1). To hold international conference attended by all regional countries in SCS (under frame work of PTS or IOC), to make detail planning of the system for conference discussion, and to encourage active participation of all ASEAN Member States. All ASEAN Member

States (Working Group) need meeting and coordination for discuss and communicate all of them under frame work PTWS or IOC.

2). To set a deadline for discussion of the plan to ensure timely response from all ASEAN Member States. The Working Group can modifies and update the plan to advice and suggestion of members.

The 2nd Year.

1). To make up a detail plan

2). The Working Group oversees the implementation of the plan.

3). To set up the SCS TWS separately or based in the organization (center) of Tsunami warning of one single country. Office, personal, and budget should be agreed by member countries. Staff will be trained in IOC/PTWS or IOWave.

The 3rd

1). ASEAN Member States on Group South China Sea TWS build up or rebuild earthquake stations and tide gauge stations.

2). ASEAN Member States can share earthquake data and water elevation

3). To set up a system of information sharing and transmission.

4). To set up South China Sea TWS, including offices, personnel, hardware and software.

The 4th Year

1). ASEAN Member States on Group South China Sea TWS build up or rebuild earthquake stations and tide gauge stations.

2). ASEAN Member States can share earthquake data and water elevation

3). To set up a system of information sharing and transmission.

4). To set up South China Sea TWS, including offices, personnel, hardware and software.

The 5th Year

1) To set up a system for information communication and communion

2) To complete the construction of South China Sea (software and hardware), and to put the system into trial use.

ANNEX IV

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ANNEX V

LIST OF ACRONYMS

AADMER	ASEAN Agreement on Disaster Management and Emergency Response
ASEAN	Association of South-East Asian Nations
BMKG	Indonesian Meteorological, Climatological and Geophysical Agency
CBDRM	Community Based Disaster Risk Management
CEA	China Earthquake Authority's
CMA	China Meteorological Agency
Comcot	Cornell Multi-grid Coupled Tsunami Model
CREX	Character Form for the Representation and Exchange of Data
CTBTO	Comprehensive Nuclear-Test-Ban Treaty Organization
DART	Deep-ocean Assessment and Reporting of Tsunamis
DRR	Disaster Risk Reduction
DVB	Digital Video Broadcast
FLAS	Fixed Line Alert System
GFZ	German Research Centre for Geosciences (GeoForschungsZentrum)
GSN	Global Seismic Network
GTS	Global Telecommunication System
HKO	Hong Kong Observatory
ICG	Intergovernmental Coordination Group
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/PTWS	Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System
ICG/PTWS-WG SCS	ICG/PTWS Regional Working Group on Tsunami Warning and Mitigation in the South China Sea Region
InaTEWS	Indonesian Tsunami Early Warning System

IOC	Intergovernmental Oceanographic Commission
IRIS	Integrated Regional Information Networks
ITIC	International Tsunami Information Centre
JICA	Japan International Cooperation Agency
JMA	Japan Meteorological Agency
JST	Japan Science and Technology Agency
MMD	Malaysia Meteorological Department
MNTEWC	Malaysian National Tsunami Early Warning Centre
MNTEWS	Malaysian National Tsunami Early Warning System
NAMRIA	National Mapping and Resource Information Authority) Philippines
NDMC	National Disaster Management Centre
NGDC	National Geophysical Data Centre
NMDIS	National Marine Data and Information Service
NMEFC	Rapid Tsunami Warning System (RTWS
NOAA	National Oceanic and Atmospheric Administration of United States of America
NTWC	National Tsunami Warning Centre
NTWC	National Tsunami Warning Centre
NWPTAC	Northwest Pacific Tsunami Advisory Center
OCD	Office of Civil Defense of Philippines
PAGASA	Philippine Atmospheric Geophysical and Astronomical Services Administration
PHIVOLCS	Philippine Institute of Volcanology and Seismology
PTWC	Pacific Tsunami Warning Center
RGF	Reciprocal Green’s Function
RTSPs	Regional Tsunami Service Providers
RTWS	Rapid Tsunami Warning System
SCMG	Sub-Committee on Meteorology and Geophysics of ASEAN

SCS	South China Sea
SCS-TWS	South China Sea Tsunami Warning System
SCS-WG	Regional Working Group on Tsunami Warning and Mitigation System for the South China Sea Region/ South China Sea Working Group
SOA	State Oceanic Administration of China
SOP	Standard Operating Procedures
TT	Task Team
TWC	Tsunami Warning Centre
UNESCO	United Nations Educational, Scientific and Cultural Organization
VSAT	Very Small Aperture Terminal
WCATWC	West Coast and Alaska Tsunami Warning Center
WESTPAC	Regional Secretariat for the Sub-Commission for the Western Pacific
WG	Working Group
WIS	WMO Information System
WMO	World Meteorological Organization

In this Series, entitled

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

167. First GOOS Users' Forum, 2000

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

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

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

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

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

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

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

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

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

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

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

179. *Cancelled*

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

231. First Meeting of the Inter-ICG Task Team 2 on Disaster Management and Preparedness (Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG), Seattle, USA, 29 November–1 December 2010

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

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

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

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

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

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