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)

Tenth Meeting

Online
28 and 30 September 2021

UNESCO

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)

Tenth Meeting

Online
28 and 30 September 2021

UNESCO 2021

ICG/PTWS-WG-SCS-X
Paris, November 2021
English only

TABLE OF CONTENTS

page

1. WELCOME AND OPENING 1

2. ORGANIZATION OF THE SESSION 1

2.1 ADOPTION OF AGENDA 1

2.2 CONDUCT OF THE SESSION, TIMETABLE AND DOCUMENTATION 1

3. REVIEW OF DECISIONS, RECOMMENDATIONS AND ACTIONS ARISING FROM ICG/PTWS-WG-SCS-IX MEETING 1

4. REPORTS 3

4.1 NATIONAL PROGRESS REPORTS 3

4.1.1 China 3
4.1.2 Indonesia 5
4.1.3 Malaysia 6
4.1.4 Philippines 7
4.1.5 Singapore 8
4.1.6 Vietnam 9

4.2 Report from SCSTAC 9

4.3 Report from NWPTAC 11

4.4 Report on Self-Developed tsunami decision supporting system at SCSTAC 11

5. SETTING UP OF BSCSTAC 12

6. FUTURE OF THE TASK TEAM ON THE ESTABLISHMENT OF A SOUTH CHINA SEA TSUNAMI ADVISORY CENTER (TT-SCSTAC) 14

7. SEISMIC AND SEA LEVEL CORE STATIONS IN THE SCS REGION FOR FUTURE ENHANCING TSUNAMI WARNING CAPABILITY 15

8. NEXT MEETING 16

9. ANY OTHER BUSINESS 16

10. SUMMARY OF DECISIONS, RECOMMENDATIONS AND ACTIONS 16

11. CLOSE OF THE MEETING 16

ANNEXES

I. AGENDA

II. ADOPTED RECOMMENDATION

III. LIST OF PARTICIPANTS

IV. LIST OF ACRONYMS

1. WELCOME AND OPENING

The Tenth meeting of the Regional Working Group on Tsunami Warning and Mitigation System for the South China Sea Region (WG-SCS-X) was held on 28 and 30 September 2021 online.

Mr Sai-Tick Chan, Chair of WG SCS, opened the meeting and welcomed participants. Mr Chan expressed thanks to the participants for contributing to the meeting, especially with the ongoing limitations due to the COVID-19 pandemic. Mr Chan remarked with appreciation that most of the Member States of the WG-SCS (eight out of nine) were present at this meeting, with only Cambodia unable to join.

2. ORGANIZATION OF THE SESSION

2.1 ADOPTION OF AGENDA

The Chair, Mr Chan, recalled that the meeting was attended by representatives from Brunei Darussalam, China, Indonesia, Malaysia, the Philippines, Singapore, Thailand and Viet Nam, as well as an invited representative from the Japan Meteorological Agency (JMA). He introduced the provisional agenda that was circulated prior to the meeting. The agenda was adopted without changes and is included under Annex I.

2.2 CONDUCT OF THE SESSION, TIMETABLE AND DOCUMENTATION

The Chair, Mr Chan, provided an overview of the schedule of all agenda items as indicated in the provisional timetable. The timetable was adopted as presented. The Chair indicated that all the documents pertinent to the meeting were available at the ICG/PTWS-WG SCS-X meeting.

3. REVIEW OF DECISIONS, RECOMMENDATIONS AND ACTIONS ARISING FROM ICG/PTWS-WG-SCS-IX MEETING

The Chair, Mr Chan, recalled that ICG/PTWS-WG-SCS-IX was held online on 27 and 28 August 2020 and was attended by China, Indonesia, Malaysia, Philippines, Singapore, Thailand and Vietnam as well as NWPTAC, PTWC and IOTIC.

The Chair also recalled that no recommendations were formally adopted at the previous meeting of the WG-SCS (ICG/PTWS-WG-SCS-IX). As such, the Chair only reviewed key topics and issues discussed at ICG/PTWS-WG-SCS IX under this agenda item.

Topic 1: Backup SCSTAC: Dr Ye Yuan (SCSTAC) remarked that SCSTAC had been working with the Hong Kong Observatory (HKO) to establish a backup centre in Hong Kong, to cater for cases of malfunctioning of the primary Center in Beijing.

Action taken: Project is on-going. HKO will report on the latest status and implementation plan under Agenda item 5.

Topic 2: Tsunami Warning Decision Support System: Mr Hongwei Li (SCSTAC/ NMEFC) reported the development of a PYTHON-based decision support system at SCSCTAC. NMEFC would seek opportunities to collaborate with other Member States to develop the system, with the purpose of helping them to enhance national-level tsunami warning capability.

Action taken: Good progress has been made, SCSTAC will provide an update under Agenda Item 4.4.

Topic 3: Operational Arrangements among TSPs: Discussion made as to the necessity of NWPTAC & SCSTAC issuing tsunami advisories for a big earthquake occurring far from their Area of Service like the 1960 Chile earthquake. It was suggested that TSPs to continue discussion on the matter and to report back to the next session.

Action taken: PTWS TSP Coordination Meeting held on 29 October 2020. TSPs agreed to more clearly define in respective User Guides the procedures for issuing products when the earthquake is located outside TSP's Area of Service. Discussion is on-going.

Topic 4: Tsunami Bulletin Format Harmonization: Tsunami bulletins issued by IOTWS, PTWC, NWPTAC and SCSTAC, including the RSTPs (India, Indonesia and Australia) are of different formats. Discussed if IOC would consider having a standard format for the advisory bulletins.

Action taken: Matter further discussed at Task Team on Tsunami Watch Operations (TT TWO) meeting held in Feb 2021, with experience of IOTWMS shared. IOTWMS felt CAP was more appropriate at the national level rather than at the regional TSP level and CAP messages made available by TSPs would not serve the intended purpose. IOTWMS recommended to encourage and assist Member States to implement CAP in their national service, including developing CAP guidance for NTWCs. Discussion on-going.

Topic 5: In-person Meeting of WG SCS: The Chair, China and the IOC Secretariat discussed and intended to postpone the next in-person meeting of WG-SCS to Jan 2021 before the ICG/PTWS-XXIX originally planned to be held in Mar 2021 in Japan.

Action taken: ICG/PTWS-XXIX was subsequently postponed to Nov 2021 and it will be held online. The in-person meeting of WG-SCS-X was also postponed and replaced by an online session (the current session).

Topic 6: Capacity building activities: SCSTAC recalled that NMEFC offered to host a Standard Operating procedures (SOP) training in 2021, which might not be possible due to funding restrictions related to the pandemic. It was noted, however, that SCSTAC's international scientist exchange program would continue.

Action taken: Owing to COVID-19, the international scientist exchange program has been on suspension since Nov 2019. Yet, an online training workshop for tsunami warning operators by SCSTAC in Dec 2021 is being planned. Short-term detachment for international scientists would also be considered subject to COVID-19 situation.

The Chair, Mr Chan, also provided a summary on key issues and actions discussed at the ICG/PTWS Steering Committee meeting from 21 to 23 September 2021. A new version of the PTWS Strategy 2022-2030 has been drafted. It was built in such a way as to provide a structured pathway for the governance and coordination of PTWS. It also developed a clear

vision, goals and objectives for PTWS. The document will be further fine-tuned and submitted to ICG/PTWS-XXIX in December 2021 for endorsement

The Chair also recalled that the ICG/PTWS Steering Committee meeting highlighted that the UN Ocean Decade provides a tremendous opportunity to address capability gaps in global tsunami warning & mitigation system. Under the scope of IOC, a UN Ocean Decade Tsunami Programme has been established and will be steered by TOWS-WG. The Scientific Committee of the Programme is being formed to draft a 10-Year Research, Development and Implementation Plan. In addition, the Tsunami Ready Coalition will be established in collaboration with national civil protection agencies and other stakeholders across the UN structure and will report to the TOWS-WG on the Tsunami Ready component.

With regards to the involvement of PTWS, the Chair noted that the ICG/PTWS Steering Committee highlighted key areas for contributions, including by establishing a Task Team to oversee the UN Ocean Decade Tsunami Programme, by conducting related and relevant projects and experiments (SMART cables, GNSS, DART), by assuming a lead role in the Tsunami Ready Coalition, by participating in all UN Ocean Decade supporting activities, and by developing capacity and education, notably through support to the Ocean Teacher Global Academy (OTGA).

The Chair also reported on ICG/PTWS Steering Committee meeting discussions regarding PacWave22. This exercise will be conducted between September and November 2022, including a communications test on 13 October 2022 (International Day for Disaster Risk Reduction). Partial results will be reported to the ICG/PTWS-XXX (November 2022), including those from the communications test, along with results from Member States who have already conducted the exercise. The evaluation period has been shortened from 21 days to 10 days. The Exercise Manual will be distributed 180 days before the exercise and will include lessons learned on conducting exercises in a pandemic context.

Finally, the Chair informed that the PTWS-XXIX will be held fully online by the end of November 2021, with interpretation facilities on Zoom. In addition, Japan has offered to host the PTWS-XXX in November 2022

4. REPORTS

4.1 NATIONAL PROGRESS REPORTS

4.1.1 China

Mr Zongchen Wang, National Marine Environmental Forecasting Centre (NMEFC), Ministry of Natural Resources of the People's Republic of China, presented the report of China. He reported that there had been no substantial changes in the availability of global and regional seismic data. The global seismic network consists of real-time, broadband seismic waveform data acquired from over 650 broadband seismic stations. These stations consist of 27 coastal seismic stations installed by Ministry of Natural Resources (MNR), 54 national seismic stations maintained by China Earthquake Administration (CEA) and around 580 IRIS and GEOFON and GEOSCOPE stations. More than 100 of these stations make up the network in the South China Sea region. The data is analysed and earthquakes are detected using SeisComp3 with CMT module and Antelope. These can be used to verify each other.

The global real-time sea-level monitoring system is comprised of nearly 600 functional tidal gauges and DART buoys via GTS. Data also comes from the sea-level monitoring facility website. The NMEFC also has access to the metadata file and Tide Tool updates from the

Pacific Tsunami Warning Center (PTWC). In addition, the NMEFC receives real-time sea-level data from 130 tidal gauges along the coast of China. Data from five of these has also been shared via GTS for the tsunami warning and mitigation system in the SCS region.

Two sets of tsunami database are in use for tsunami hazard analysis along the coast of China. These respectively cover the Northwest Pacific region (the NW Pacific scenario database) and around the Pacific Ocean (the Pacific unit source database). On-the-fly tsunami forecast model run on GPU was capable of accomplishing a Pacific tsunami forecast within 45 seconds. In the Northwest Pacific and SCS region, the respective model can be accomplished in less than 5 seconds. In addition, another tsunami forecasting system has been developed in the North Indian Ocean. The relevant products and messages are to be sent to the Marine Service website or the Marine Silk Road, serving for the relevant domestic users and stakeholders.

The NMEFC also developed a two-layer nested model, to be used for smaller areas, which improves tsunami simulation accuracy. They collaborated with Macau to establish a refined model of 15 arc-sec grid space for Macau. This model requires 150 seconds to produce a tsunami forecast for Macau from tsunami cells in the SCS region. A refined four-layer nested model with 90 metre resolution was also established for Hong Kong by NMEFC and the Hong Kong Observatory (HKO). This model requires less than 3 minutes to produce a tsunami forecast. This performance is achievable with the GPU accelerator and code optimization.

Due to technical and maintenance reasons, the SCSTAC website has been transferred, and is hosted under a new domain name.

Mr Wang reported that on tsunami message dissemination. In 2020, China's national tsunami warning centre (NTWC) responded to 37 major earthquakes and issued 62 tsunami information bulletins, with an average latency of 8.8 mins for the first message. There has been a decreasing trend over the last four years with regard to dissemination time for the first message. Until September 2021, there have been a few tsunamis triggered by earthquakes with Mw8.0 or higher. The first is the tsunami generated by the Kermadec earthquake on 4 March 2021. The maximum amplitude of this tsunami was over 50 centimetres. According to the Standard Operating Procedures (SOPs), the watchstander was requested to use real-time model forecast relying on focal mechanism. NMEFC sent a message 15 minutes after the earthquake whilst the PTWC sent a message nine minutes after the earthquake; however, there were no quantitative products in the first message. The other tsunami earthquake that occurred in 2021 took place in the Alaska Peninsula. NMEFC sent a message 16 minutes after the earthquake whilst the PTWC sent one eight minutes after the earthquake. Dr Wang also presented message dissemination during the Mexico Guerrero earthquake tsunami in September 2021. The first messages of NMEFC and PTWC were issued at nearly the same time (eight and nine minutes after the earthquake, respectively).

With regards to mitigation, NMEFC created a tsunami hazard assessment system. In addition, NMEFC conducted a domestic desk drill on 5 November 2020 for WTAD. The exercise scenario was of an earthquake with Mw9.0 in Ryukyu trench. The threat was for potential catastrophic impact in Jiangsu, Shanghai, Zhejiang and Fujian. Warning messages were sent and received effectively in 10 minutes.

In order to provide more stable and sustainable tsunami warning service in the SCS region, a back-up centre for SCSTAC is under construction hosted by the HKO. In addition, another back-up centre has been set up in the Shunyi District of Beijing. A training for HKO staff was conducted in November 2020 on basic earthquake and tsunami knowledge, tsunami warning technology, and tsunami DSS and routine operation.

Finally, NMEFC has also supported publicising tsunami science, notably during national prevention and mitigation day, world oceans day, and WTAD.

Malaysia inquired whether China plans to maintain use of SeisComp3 and Antelope, or forego one for the other. China responded that SeisComp3 has less latency, but Antelope can provide more stable results. As such, the first message is usually from SeisComp3, and China mainly relies on SeisComp3.

4.1.2 Indonesia

Dr Karyono, Agency for Meteorology Climatology and Geophysics (BMKG), presented the progress report for Indonesia. Dr Karyono recalled the high level of seismic and tsunami activity in Indonesia due to is location along the Pacific Ring of Fire, with 295 active faults and five active subduction zones. The latter are the Sunda Subduction, the Banda Subduction, the North Sulawesi Subduction, the Molucca Sea Subduction and the North Papua Subduction. In addition, 46 percent of Indonesia's coasts are threatened by tsunamis.

Based on this threat, the Indonesia Tsunami Early Warning System (InaTEWS) was created on 1 November 2008. BMKG is the agency which operates InaTEWS. The main product of InaTEWS is the earthquake information and tsunami warning. It is necessary to disseminate earthquake information and tsunami warning within five minutes after an earthquake has occurred. The objectives of InaTEWS is the timely detection of earthquake events and provision of tsunami warning to responsible institutions and people. This allows for an appropriate response of communities to reduce and minimize the impacts of the disaster. Dr Karyono highlighted that InaTEWS receives support from myriad national and international institutions.

Dr Karyono next reported on InaTEWS's seismic monitoring system, noting that they currently have 411 seismic stations. InaTEWS also receives support from seismic stations of other countries (about 200 stations). He underlined the role of international support and cooperation in the deployment of seismic centres. Indeed, Australia, China, Germany, Japan, the United States (US), and CTBTO contributed seismic stations and/or technical capacity building. Data and information are also received by BMKG from the sea level monitoring system. However, Dr Karyono informed that BMKG is not in charge of this system and it is managed by other national institutions.

Regarding the processing system of InaTEWS, Dr Karyono reported that SeisComp3 is used for seismic processing whilst the Toast application is employed for tsunami processing. Through seismic processing is generated earthquake information, and through the tsunami processing is produced tsunami early warning. Two databases are used for tsunami processing; these are the precalculated Tsunami Database (Tsunawi) and on the fly or real time simulation. The main InaTEWS processing system centre is located in Jakarta, with a back-up system in Bali. Trainings are also provided to support processing.

Dr Karyono presented the dissemination system flowchart for InaTEWS. He noted that InaTEWS used several different communication modes including SMS, email, fax, Warning Receiver System (WRS), website, and social media. Information and messages, based on SeisComp3 and Toast data, is disseminated by BMKG to stakeholders and the community. Some dissemination methods only go to stakeholders whilst some also go directly to the community. Stakeholders include local governments, BPBD, BNPB, the media, the police, the army, ports, harbours, airports, NTWCs, etc. InaTEWS uses the WRS new generation which has features such as: real-time earthquake information, sound of alarm when an earthquake occurs, earthquake information and tsunami warning based on standard operating procedures

(SOPs), SMS forwarding, earthquake information and tsunami warning on screen, and historical data for the last of 20 days.

Dr Karyono outlined InaTEWS's responsibilities in the globally, which include being tsunami service provider for the Indian Ocean, the ASEAN Earthquake Information Centre, and NTWC for the Indian Ocean, Pacific and South China Sea regions.

The BMKG, as the agency which operates the InaTEWS, has participated in and conducted capacity building activities. The latter include formal graduate programmes and training for staff as well as outreach activities such as the Indonesia Tsunami Ready (InaTR). Training programmes for operators including an online training course on advance hazard earthquake and tsunamis as well as an online training course on seismic network data quality. Experts from USGS were invited to give lectures for the NTWC operators. InaTR is an outreach programme of community capacity building by examining and implementing 12 indicators from the UNESCO/IOC Tsunami Ready community. The InaTR is conducted in the following ways: Field survey and advocating to fulfill the 12 indicators, two-day intensive workshop to evaluate and finalise all the indicators, and a tsunami drill for schools through "BMKG Goes to School". The InaTR has been included in Indonesia's national priority programme by the Ministry of National Development Planning Agency (BAPPENAS). Currently, 30 communities are expected to participate in 2021.

4.1.3 Malaysia

Mr. Zaidi Bin Zainal Abidin of the Malaysian Meteorological Department (MMD), presented its report providing an update on the status of the Tsunami Early Warning System in Malaysia.

He reported that the Malaysian National Tsunami Early Warning System (MNTEWS) has been renamed to be the National Weather and Geophysics Operation Centre. He recalled that the objective of this agency is to provide early warning on tsunamis generated in the Indian Ocean, the South China Sea or the Pacific Ocean that may affect Malaysia.

There are three elements in the Tsunami Early Warning System in Malaysia: data collection, processing, and dissemination. Data is collected from 77 seismic stations, 17 tidal gauge stations, 18 coastal camera systems, and through linkages to international tsunami watch centres such as TSPs, JMA, and PTWC. Through the VSAT communications system, this data is sent to be processed. Processing occurs through software processing (using SeisComp3 and Antelope), tsunami databases, and Admis. This step produces products which include information, ShakeMaps, and warnings. Finally, earthquake information and tsunami warning is disseminated, notably through sirens, the myCursa application, social media, mass media and television, website and mygempa, SMS, email and fax.

The Covid 19 pandemic presented several challenges for Tsunami Early Warning System in Malaysia. Nonetheless, activities were able to continue because the Malaysian MET office was permitted to stay open as an essential service. Challenges due to Covid 19 included difficulties when officers were infected and/or quarantined. In addition, conducting repairs and receiving replacement parts for seismic equipment were deferred, especially to Sabah and Sarawak due to a mandatory quarantine of 14 days upon arrival at the time. Any activities that involved groups of people (e.g. tsunami drill exercises or public awareness campaigns) were prohibited and deferred. Nonetheless, public awareness campaigns were conducted via infographics on social media.

Under the Business Continuity Plan (BCP) through its Disaster Response Plan (DRP) a simulation was done for a scenario that involved the closure of the National Weather and

Geophysics Operation Centre on 15 October 2020 with the “Work From Home (WFH)” mode activated. This simulation was done in order to assess whether it was feasible for operators to operate from home using a home PC/laptop and a home internet, especially for the operators who were not infected but suspected and thus home quarantined. Findings from this simulation found that any WFH activities, if any, necessitate a stable internet connection. In addition, online meetings are still needed even if the pandemic becomes an endemic. Finally, WFH is viable for the operations centre if certain conditions are met.

Dr Karyono (Indonesia) inquired about the type of tsunami model used by Malaysia. Mr. Zaidi Bin Zainal Abidin responded that they are using Tsunami M1 and Tsunami M2. Dr Karyono followed up asking who these were deployed by, and Mr. Zaidi Bin Zainal Abidin responded that it was from Japan.

4.1.4 Philippines

Mr Ishmael Narag, Philippine Institute of Volcanology and Seismology (PHIVOLCS), presented the report of Philippines. He noted that the Philippines has many earthquake sources, which sometimes cause tsunamis.

Mr Narag reported that the Philippines seismic network currently has 111 seismic network stations as well as volcano observatories. Three additional seismic stations were commissioned this year, mainly in the Southwestern area of the Philippines. These new seismic stations are located in San Policarpo (Eastern Samar), Siocon (Zamboanga del Norte) and Gloria (Oriental Mindoro). Additional stations are also planned with the objective of 112 stations in 2021 and 115 stations in 2022.

There are also several ongoing activities to further develop the network, including planned acquisition of additional earthquake monitoring and communications equipment. The creation of the Mindanao Cluster Centre (Davao) has also recently been commissioned, along with the construction of the Visasyas Cluster Centre (Cebu). The PHIVOLCS Mindanao Cluster Centre for Earthquake and Tsunami (PMCMCET) will serve as a backup receiving centre.

Processing of the seismic data network has enabled analysis of earthquake information and patterns. Mr Narag presented heatmaps of earthquake data that show the coverage of area where earthquakes of different magnitudes could be located, thus essentially indicating the degree of reliability of the network in locating events. Mr Narag also shared a map with plotted earthquakes to visualise patterns, noting that PHIVOLCS does focal mechanism solutions of the major earthquake events.

Mr Narag next presented on sea level monitoring stations, noting although 19 such stations currently installed in the Philippines, the pandemic has hindered maintenance. Nonetheless, some of the stations were rehabilitated during the third quarter of 2021. Mr Narag noted that during the 12 August 2021 earthquake event which occurred offshore of Mati with a Mw7.1, a small sea level change (less than eight centimetres) was detected by the sea level monitoring stations. This was also reported by the PTWS sea level monitoring facility.

The PHIVOLCS is also in charge of releasing tsunami information to the public (this information is also available on their website). Mr Narag noted that most messages were only tsunami advisories. He also noted that a new template had been created for the warning and advisory products.

Capacity enhancement of technical staff is also critical and ongoing. As such, a drill is usually conducted every quarter. Recently, a tabletop exercise has also been performed in order to improve the Standard Operating Procedures (SOPs).

There are several platforms where earthquake, tsunami and volcanic information is disseminated. These include a mobile application, online platforms that estimate whether your structure is capable of withstanding an earthquake.

4.1.5 Singapore

Mr Eugene Chong, Senior Meteorologist, Meteorological Service Singapore (MSS), presented the report of Singapore.

He recalled that the national seismic network was installed in 1997. In the wake of the 2004 Indian Ocean tsunami, the National Tsunami Early Warning System (TEWS) was installed between 2007 and 2008. This included the establishment of links with regional /international tsunami warning centres as well as completed tsunami simulation studies and models. At this time, Antelope was primarily used to process data; today, however, the MSS mainly employs SeisComp3 and the TWOS system. In addition, a multi-agency Tsunami Task Force (TTF) was also formed. Between 2008 and 2010, the Tsunami Response Plan (TRP) was established, whereby Members of TTF submitted individual Support Plans for the TRP. This Plan was endorsed by Crisis Management Group (CMG) for Tsunamis. The TRP was updated between 2018 and 2020. During this time, the Members of the TTF were also updated, with some of them choosing to resubmit new Support Plans. Since 2020, the TTF is Chaired by the Director-General of the Meteorological Service Singapore (MSS) and Members include selected Ministries, government agencies, and statutory bodies.

In 2011 and 2012, tabletop exercises were conducted with TTF and other agencies. These exercises are typically conducted with operational staff. A tsunami event scenario is selected and agencies must simulate their behaviours and actions during such an event. Most recently in 2020, an internal tabletop exercise was conducted as part of the IOWAVE Exercise. Singapore participated in both IOWAVE and PacWave Exercises since 2006.

The primary objectives of the TRP are to mitigate impacts in the event of a tsunami and to manage the consequences if a tsunami event takes place. For the former, it provides for early alerts and warnings to be sent to all response agencies under the TTF and for respective agencies to take early preventative and necessary action.

Mr Chong presented examples of simulation studies that have been conducted to assess the likelihood of tsunamis affecting Singapore. He noted that although Singapore does not lie on any seismically active faults, it is nonetheless surrounded by water and therefore vulnerable. Models suggest that Singapore may be impacted by a tsunami generated in the Andaman Sea; however, the tsunami would only impact at least 12 hours after generation and wave height is likely to be below one metre. Another scenario explored was for a tsunami generated by a large earthquake in the Manilla Trench. In this case, the tsunami is also only expected to impact Singapore between 11 and 12 hours, with correspondingly low wave heights.

Mr Chong also indicated Singapore’s activation alert levels that have been created under the TRP. These include six alert levels: earthquake alert, tsunami watch, tsunami advisory, tsunami warning, tsunami report, and tsunami information.

Mr Chan, the Chair, enquired whether the MSS has tsunami wave height thresholds related to their alert system. Mr Chong explained that the MSS does not adopt definite thresholds because the wave height when a tsunami reaches Singapore is difficult to assess.

4.1.6 Vietnam

Dr Truyen Pham, of the Institute of Geophysics (IGP) within the Viet Nam Academy of Science and Technology (VAST), presented the report of Viet Nam.

He recalled that the Vietnam Earthquake Information and Tsunami Warning Centre (EITW) was established under the Institute of Geophysics in 2007.

The Vietnam Seismic Network (VSN) consists of two different networks: the national network with 31 broadband seismometers and the local network with 50 temporary seismic stations that have been deployed for monitoring seismic activity of hydro power plants and conducting seismic research at local scales. The national network only detects larger earthquakes (Mw 3.0 or higher), whereas the local network can detect those smaller earthquakes (including under Mw 1.0). Mr Pham noted that new seismic stations were deployed after the Mw 4.9 earthquake that occurred on 16 June 2020 in northern Vietnam. The Vietnam sea level network include 18 tide gauge stations deployed along the coast. In addition, Vietnam is sharing two tide gauge stations with China.

Mr Pham next presented a diagram illustrating the functioning of the EITW. He noted that the regional seismic network and national seismic network provide the data for seismic data processing. This, along with tsunami scenarios, sea level stations and tsunami buoys provide the knowledge for the EITW, which then disseminates earthquake information for events above Mw 3.5 and disseminates tsunami information for events above Mw 6.5. Earthquake and tsunami information is disseminated by phone, fax, TV, radio, government offices and related agencies. Tsunami information is also disseminated through the alert system.

Mr Pham shared a map of seismic sources, noting that there were an estimated 37 seismic sources in Vietnam. He also showed the national seismic hazard map which is based on a 475-year return period. The latter is disseminated to the public and can notably inform building infrastructure. The EITW also issues natural disaster risk scales for earthquakes (includes five levels and is based on magnitudes) and for tsunamis. The latter includes five steps and is related to wave height and tsunami intensity.

Finally, Mr Pham reported on ongoing activities, including developing an earthquake and tsunami risk reduction strategy at country, community, and local levels; strengthening earthquake and tsunami preparedness for effective response at all levels; and the continued operation of the seismic networks and tide gauges for tsunami early warning purpose.

4.2 REPORT FROM SCSTAC

Dr Zhiguo Xu, the Acting Director of Tsunami Warning Centre/NMEFC, presented the report of the SCSTAC.

Dr Xu began by presenting a map of the existing services of the global TEWS. He also recalled the area of service of the South China Sea Tsunami Warning and Mitigation System (SCSTWS). According to the ICG/PTWS, it encompasses all coasts of the South China Sea and the adjacent Sulu Sea and Celebes Sea, separated by Palawan and the Sulu Archipelago from north to south respectively. Nine nations are included in this area: Brunei, Cambodia, China, Indonesia, Malaysia, Philippines, Singapore, Thailand and Vietnam.

Dr Xu highlighted that the SCSTAC has been in full operation since 5 November 2019. The role of SCSTAC includes the acquisition of earthquake information, sea level monitoring,

a tsunami scenario database, a tsunami parallel model, a tsunami analysis tool, and the production and dissemination of information and products. According to SCSTAC's SOPs, SCSTAC must produce tsunami products for earthquakes equal to or above Mw 6.0 in the South China Sea region. These products include tsunami information and a tsunami threat message.

Dr Xu indicated that between June 2020 and September 2021, SCSTAC issued 12 tsunami bulletins, noting that most earthquakes were located in the eastern part of the SCS. He also stated that SCSTAC key performance indicators (KPIs) were evaluated for full operation, noting that all targets had been reached. The only KPI that was not confirmed was the accuracy of the Estimated Time of Arrival (ETA) and amplitudes of the tsunamis actually is triggered; this is because no earthquake of Mw 7.1 or higher occurred in SCSTAC's area of service during this time, thus the KPI could not be tested.

He also noted that a new and updated website was available for SCSTAC, where additional information can be found. Dr Xu reported that SCSTAC had developed a tsunami warning decision supporting system based on Python to improve their tsunami warning capability. Key features of this system will include: Real-time monitoring, receiving and processing of seismic and sea level data; a tsunami scenario database; GPU parallel tsunami numerical simulation; automatic generation and release of tsunami warning products; an integrated decision support system for tsunami warning; and a user-friendly, comprehensive, well-maintained and open-source software. The software will be upgraded by the end of 2021.

With regard to tsunami warning capacity enhancement, SCSTAC has extended tsunami warning technological support to the backup SCSTAC Centre (BSCSTAC) in Hong Kong, as well as to the tsunami warning system in Macau. For instance, technical staff from SCSTAC installed a tsunami simulation system in Macau. The BSCSTAC was created with the Hong Kong Observatory (HKO). In addition, a backup tsunami warning system was installed in Huairou District Beijing, China, in order to implement independent function backup and the synchronization, though not dependence, of data.

SCSTAC has also developed a new tsunami generation model, which has 2D depth-averaged shallow water equations in vector invariant form, unstructured hexagonal mesh generation algorithm by SCVT, finite volume discretization, third-order/fourth-order Runge–Kutta scheme, Arakawa C-grid, global and regional simulation ability, and is GPU-accelerated.

Next, Dr Xu reported on communications tests conducted on 28 January and 28 May 2021, noting that six Member States had responded to the dummy information. He thanked the Secretariat and Member States. He also noted that SCSTAC conducted the 2020 PacWave Exercise, using the dummy information to test communications. SCSTAC has also conducted technical training activities since June 2020, including related to seismic analysis (earthquake location/magnitude/depth, operation seismic monitoring system, and rapid characterization of tsunami source), sea level data analysis (detect, confirm and refine tsunami waves), tsunami forecasting (TTT/COMCOT), message dissemination and routine drills. In addition, SCSTAC has also participated in several meetings including two PTWS Steering Committee meetings and an international workshop in Qingdao, China.

Finally, Dr Xu spoke about future plans for the SCSTAC, noting that SCSTAC would join the ICG/PTWS-XXIX Meeting (December 2021), continue to perform communications tests, conduct an online training workshop on tsunami forecasting and risk assessment for tsunami warning operators in the South China Sea region (December 2021, hosted by China), and provide opportunities for in-person education, outreach and training activities in the region. He noted that the latter would be dependent on the COVID-19 pandemic.

4.3 REPORT FROM NWPTAC

Mr Yuji Nishimae, Scientific Officer for International Tsunami Information at the Japan Meteorological Agency (JMA), presented the report for the NWPTAC. He began by noting major activities of the NWPTAC between June 2020 and August 2021. On 5 November 2019, the NWPTAC terminated its interim service for the South China region when full operation of SCSTAC began (areas of service were changed). In November 2020, the JMA moved to its new building and the NWPTAC started its operations at this new building. On 14 July 2020, 15 February 2021 and 3 August 2021, the NWPTAC also performed communications tests.

Mr Nishimae also highlighted that the MWPTAC issued 14 advisory messages since June 2020, noting that on average the advisories were issued within ten minutes. He also presented results of communications tests conducted since 2012, noting that these usually occur biannually. He reported that approximately 70 percent of countries had sent back acknowledgements of receipt to NWPTAC and that the number of acknowledgments was increasing.

4.4 REPORT ON SELF-DEVELOPED TSUNAMI DECISION SUPPORTING SYSTEM AT SCSTAC

Mr Hongwei Li, SCSTAC, presented the report on the structure options of the decision supporting system (DSS) at SCSTAC. He began by noting that the DSS at SCSTAC was self-developed, is well-designed and can save several minutes for tsunami warning, and is an open-source system, and is easy to maintain. The Smart Tsunami Information Process System (STIPS) started to be created in 2018 and trial operation will begin this year.

Mr Li next explained the structure of the DSS by identifying the modules of the STIPS (see Figure 1 below). The information display module is mainly used to show static information on the map (forecast region, tidal stations), show dynamic information (earthquake location, forecast result). Both an online map (currently under test) and offline map are used. The earthquake analysis module outlines all the earthquake events and their parameters and estimates parameters based on historical events and observations. Events can be inserted manually to conduct exercises, with the ability to set preferred origin and plot earthquake locations on the map. The tsunami forecast module estimates tsunami arrival time of a selected earthquake, calculates maximum tsunami wave height by scenario database or on-the-fly simulation, and shows tsunami forecast results (wave height list and maps). The sea-level observation module shows data latency of each tidal station by colours and does operations on sea level data. Within this module, there is a station map and list for users to search information, and they can select maximum wave height and save. Finally, in the bulletin generation module, the user can select a product template based on both earthquake parameters and simulation, generate a tsunami bulletin quickly (doc, txt, html), and send the product via diverse methods.

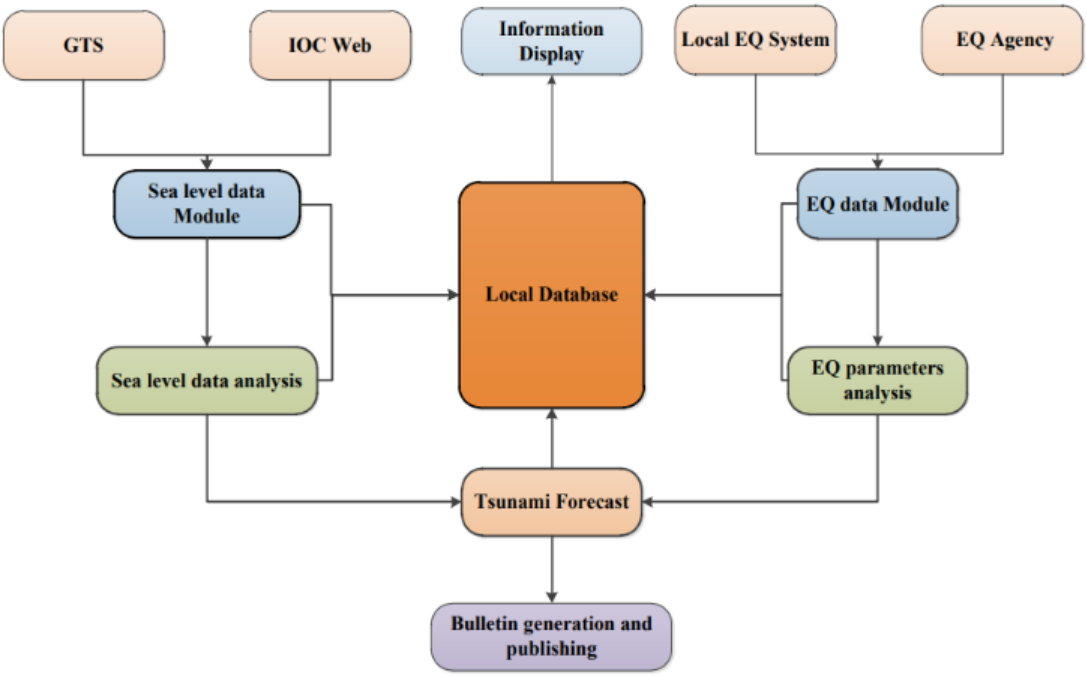

Figure 1. The structure of the DSS of SCSTAC

There is also a DSS for BSCSTAC which began this year and is still under tests (these are predicted to finish this year). Although the structure is the same, there are some differences in function.

Mr Li finished by identifying future work relating to the DSS. He noted that the English version of the DSS is almost complete, that they are working on making the system more user-friendly, that testing for bugs and improvements will continue, and that additional work will be done on stability and fluency.

Dr Karyono (Indonesia) enquired whether GNSS data was incorporated in the DSS. Dr Li (SCSTAC) responded that GNSS data was not included. Currently, the only data that is included is from seismic and sea level stations.

The Chair noted that for any additional information about the SCSTAC DSS, Members of the WG could contact China directly.

5. SETTING UP OF BSCSTAC

Mr Johnny Cheung, HKO, presented the report on the setting up of the backup South China Sea Tsunami Advisory Centre (BSCSTAC).

He recalled that during the ICG/PTWS-WG-SCS-IX on 27-28 August 2020, it was agreed that SCSTAC should work with the Hong Kong Observatory (HKO) to build backup capability. The BSCSTAC will be operated at the Central Forecasting Office (CFO) at the HKO Headquarters. It will be manned round the clock by duty officers and will also be responsible for global earthquake monitoring and local tsunami warning. It is scheduled to be activated during the cool season each year in consultation with SCSTAC.

The BSCSTAC DSS was adapted from the DSS of SCSTAC. It includes full graphical UI, real time seismic and water level monitoring, GPU-accelerated COMCOT, and auto preparation and dissemination of products. The modules of this DSS include earthquake

monitoring, earthquake analysis, tsunami analysis, tide monitoring, and product dissemination modules.

The BSCSTAC will use several different channels to disseminate products including GTS, the website, facsimile, and email. The website is hosted by HKO, with the domain name to be confirmed.

Mr Cheung next reported on the capacity and capacity building of BSCSTAC. He noted that SCSTAC and BSCSTAC have similar magnitude detection capabilities in the South China Sea, similar earthquake location capabilities in the South China Sea. Indeed, for the latter, detection time is within 100 seconds. SCSTAC and BSCSTAC also have similar tsunami detecting capabilities in South China Sea. Mr Cheung also reported that a two-day remote training was conducted by SCSTAC in November 2020 to strengthen HKO's capabilities relating to earthquake monitoring and tsunami warning.

Mr Cheung next shared BSCSTAC's tentative implementation programme. The BSCSTAC's website will be ready for testing in December 2021 and a communications test with the TWC/TWFP will be arranged in February 2022. Trial operation of BSCSTAC is tentatively planned for March 2022, with activation and full operation scheduled for the last quarter of 2022.

There will be two different modes of activation for BSCSTAC: scheduled and unscheduled activation. Scheduled activation will take place during autumn and winter, whilst unscheduled activation will only occur when SCSTAC has experienced unforeseen interruptions in operation. For scheduled activation, a message will be issued by email one week before the scheduled activation, with another issued upon the activation of BSCSTAC under scheduled activation via email, fax, and GTS. For unscheduled activation, a message will be issued upon the activation of BSCSTAC via email, fax, and GTS.

Mr Cheung presented recommendations relating to BSCSTAC.

Dr Karyono (Indonesia) enquired whether the DSS of BSCSTAC was created by a third party, and Mr Cheung responded that BSCSTAC adopted the system developed by SCSTAC.

Mr Nishimae (JMA) enquired how the performance of BSCSTAC had been and will be evaluated. Mr Cheung explained that BSCSTAC's performance was judged against the documents which set out the purpose and functions of SCSTAC; these documents essentially serve as a checklist for performance. Overall, BSCSTAC must follow the same standards as SCSTAC. He added that BSCSTAC's technical capability was also tested by using sea level and seismic data.

Mr Nishimae also requested clarification on the heading used in the GTS message (WESS31 VHHH). Mr Cheung clarified that, although similar, this heading will be different for SCSTAC and BSCSTAC so that Member States can differentiate. The Chair, Mr Chan, further clarified that during the trial period BSCSTAC will not be issuing bulletins to Member States.

Mr Ismael Narag (Philippines) asked clarifications on the method for evaluating BSCSTAC's technical performance. Mr Cheung responded that whilst BSCSTAC is in trial run and operating at the same time as SCSTAC, the results of BSCSTAC will be compared to those of SCSTAC to ensure they are sufficient.

6. FUTURE OF THE TASK TEAM ON THE ESTABLISHMENT OF A SOUTH CHINA SEA TSUNAMI ADVISORY CENTER (TT-SCSTAC)

Mr Dakui Wang, NMEFC China, presented on this item. He began by recalling the history of the TT-SCSTAC. Mr Wang recalled that at the ICG/PTWS SCS-WG I, in 2011, the SCS WG proposed to create a Task Team to advise the WG on the establishment of a Regional Tsunami Warning Centre, with the Terms of Reference for the Task Teams to be developed at the following SCS WG meeting for submission to the next session of the ICG/PTWS. However, no decisions or recommendations were made during this meeting. At the SCS-WG II in 2012, the WG decided to establish a SCS-WG Task Team on the establishment of a Regional Tsunami Advisory Centre (SCSTAC) and agreed to specific Term of Reference. At the ICG/PTWS XXV session in 2013, the ICG/PTWS decided to establish a Task Team on the Establishment of a South China Sea Tsunami Advisory Centre of the Regional Working Group on the Tsunami Warning and Mitigation in the South China Sea. The WG met intra-sessionally during the meeting and elected Dr. Ye Yuan (China) as Chair of TT-SCSTAC.

The first meeting of the TT-SCSTAC took place in April 2014 and set out the missions and duties of the SCSTAC, operational requirements, performance indicators, types and criteria of the operational products, and telecommunication. It also established working plans, including for regional monitoring capability, the design of tsunami advisory products, and DSS and forecasting skills.

At the ad hoc TT-SCSTAC meeting in February 2015, the TT chair reported on the Draft Plan on Tsunami Advisory Products for the South China Sea Tsunami Warning and Mitigation System and on the establishment of a SCSTAC: Requirement and Implementation Plan, which was accepted by the SCS WG IV meeting.

During the second meeting of the TT-SCSTAC, in February 2015, the TT decided to make a recommendation to the WG SCS-VI on the endorsement of the trial and full operation of the SCSTAC. The third meeting of the TT-SCSTAC (March 2018) reviewed the Terms of Reference and membership of the TT, and discussed SCSTAC tsunami advisory products, arrangements for the trial operation of SCSTAC, and the SCS SOP training workshop (2018).

The TT-SCSTAC recommended to the SCS WG to dissolve the TT-SCSTAC, noting that SCSTAC has been in full / official operation since 5 November 2019, and the purpose of the TT has been completed successfully. The TT-SCSTAC also recommended to establish a SCS WG Task Team on Capacity Development and Services. Mr Wang presented a draft of Terms of reference for this new WG with the Group.

The Group agreed to the establishment of a SCS WG Task Team on Capacity Development and Services.

China nominated Mr Zhiguo Xu for the position of Chair of the SCS WG Task Team on Capacity Development and Services.

Mr Narag (Philippines) expressed its support for the SCS WG Task Team on Capacity Development and Services and Terms of Reference.

Dr Karyono (Indonesia) also expressed its support for the SCS WG Task Team on Capacity Development and Services and suggested that the Chair and Vice-Chair of this TT should come from China and Hong Kong. The Chair, Mr Chan, noted that, because Hong Kong is not a Member State of the IOC, this would mean that the TT would have a Chair and Vice-Chair from China, in terms of IOC Member State recognition. Mr Chan noted that this would not be desirable.

Mr Karyono suggested that a country most geographically close to the SCS should be nominated for Vice-Chair, specifically highlighting Malaysia or the Philippines. Ms Anugrah (Malaysia), supported the nomination of the Philippines.

Mr Narag (the Philippines) noted that the Philippines agrees in principle with the objectives of the new TT, and noted that their nomination would be discussed internally.

The Chair invited Malaysia and the Philippines to nominate a person for the position of Vice-Chair before the ICG/PTWS XXIX meeting in December 2021.

7. SEISMIC AND SEA LEVEL CORE STATIONS IN THE SCS REGION FOR FUTURE ENHANCING TSUNAMI WARNING CAPABILITY

Ms TingTing Fan, SCSTAC, began by reporting on the purpose of data sharing. She noted that seismic and sea level measurements are critical for tsunami warning because they support tsunami detection in real time, tsunami threat evaluation, characteristic parameters extraction, and tsunami forecast correction, and tsunami source inversion.

She next provided an update on the progress on the seismic and sea level core stations in the SCS region. An inventory of seismic and sea level stations in the SCS region was requested to be compiled at the SCS WG-IV meeting in 2015. At the 2017 meeting, the lists of seismic and sea level stations were determined. The SCS WG-VII meeting in 2018 requested SCSTAC to provide the reports on data availability of core stations, which were presented the following year at SCS WG-VIII.

With regards to methods for sharing seismic data in the SCS, a data sharing server was built for seismic core stations using SeedLink client for exchange and sharing of seismic data streams for SCS WG Member States. There are 115 seismic core stations in the SCS region that are intended to be shared, although currently there are only 51 publicly accessible. For sharing of sea level data, a data sharing server for sea level core stations in real-time was built by SCSTAC ftp for special users from SCS WG Member States. There are 71 sea level stations in the SCS region that are intended to be shared, although currently there are only 17 publicly accessible.

Ms Fan next reported on the KPIs for evaluation of the availability of seismic and sea level data, noting that SCSTAC provides quarterly reports on data availability. She shared tables and maps illustrating the continuous rate of seismic and sea level stations this year (by quarter). For seismic stations, of the 51 publicly accessible, 45 have data available. For the availability of core sea level station, only six out of the 17 publicly available stations have a continuous rate above 70 percent. Ms Fan noted that a notable issue was therefore that data continuous rate needs to be improved, seismic and sea level monitoring gaps exist in tsunami-prone areas, and that no tsunami buoy is currently in service within the area

Ms Fan **encouraged** Member States of the SCS WG to share more seismic and sea level stations to further enhance the tsunami warning capability in the South China Sea region, especially for the Sulu Sea, Celebes Seas and North Borneo.

Dr Karyono (Indonesia) noted that Ms Fan only mentioned eight seismic stations for Indonesia, when there are actually 21 publicly available. He offered that he could be contacted to help with access via SeedLink. In addition, Dr Karyono noted that sea level data is managed by a different institution in Indonesia, but that the data is available through a website portal that can be accessed publicly. The Chair, Mr Chan, suggested that SCSTAC contact Indonesia directly to acquire all this data.

8. NEXT MEETING

The Chair, Mr Sai-Tick Chan, recalled that the WG SCS-VIII accepted the offer of China to host WG SCS-IX in Guangzhou, China in March 2020. At that time, Malaysia (Dr Bun Liong Saw) also volunteered to host WG SCS-X. However, in-person meetings of the SCS WG were cancelled due to the COVID-19 pandemic. As such, WG SCS-IX was held online on 27-28 August 2020 and WG-SCS-X was also held online on 28 and 30 September 2021.

The Chair **noted** the prevailing travel restrictions imposed by various countries due to COVID-19.

The Group decided to accept the offer of China to host the next meeting of the ICG/PTWS WG SCS-XI in 2022 in Guangzhou, Guangdong Province, China, with dates and venue to be discussed and determined in consultation with the Secretariat and the Chairperson.

9. ANY OTHER BUSINESS

Chair Mr Sai-Tick Chan noted the need to elect office bearers. Following the rules of procedure which apply to IOC subsidiary bodies, the Chair and at least one Vice-Chair must be elected either by the ICG/PTWS or members of WG for two years with possible re-election of one term in the same position. The current Chair, Mr Chan, has already served two terms as Chair of WG SCS since Mar 2017 (elected at ICG/PTWS XXVII).

As such, the Chair invited Member States to submit nominations by email for the new Chair/Vice-Chair of the WG. The Chair noted that thus far, only one nomination from China had been received for Dr Dakui Wang for the position of Chair. Mr Chan encouraged members of the WG to nominate a person for the role of Vice-Chair, recalling that this position had been left vacant for at least the last two terms.

The Group **accepted the nomination from China of Dr Dakui Wang as Chair of WG-SCS** in the next intersessional period of ICG/PTWS.

The Group **also decided** that WG SCS Member States send Vice-Chair nominations for WG SCS, if any, to the IOC Secretariat before ICG/PTWS-XXIX.

Chair Mr Sai-Tick Chan noted that the Terms of Reference of the WG SCS remained unchanged.

10. SUMMARY OF DECISIONS, RECOMMENDATIONS AND ACTIONS

Based on the reports and discussions, **the WG-SCS adopted** Recommendation ICG/PTWS-WG-SCS-X.1 and ICG/PTWS-WG-SCS-X.2.

11. CLOSE OF THE MEETING

Chair Mr Sai-Tick Chan closed the meeting of 30 September 2021 at 10:30am (CEST), thanking all participants for their active participation and efficient discussions. The Chair also expressed thanks to the Secretariat for organisation and logistic support of the meeting.

The Chair also expressed appreciation for his time as Chair of the WG and wished all successes to Dr Dakui Wang as the next Chair of the WG.

Mr Narag also expressed thanks to Mr Chan for his role as WG Chair.

The Technical Secretary, Mr Bernardo Aliaga, expressed deep gratitude for the leadership of Mr Chan over his last two terms as Chair of the WG. Mr Aliaga also thanked Member States, noting the high level of participation during this past meeting.

ANNEX I

AGENDA

1. WELCOME AND OPENING

2. ORGANIZATION OF THE SESSION

2.1. ADOPTION OF AGENDA

2.2. CONDUCT OF THE SESSION, TIMETABLE AND DOCUMENTATION

3. REVIEW OF DECISIONS, RECOMMENDATIONS AND ACTIONS ARISING FROM ICG/PTWS WG-SCS-VII MEETING

4. REPORTS

4.1. NATIONAL PROGRESS REPORTS

4.1.1. CHINA

4.1.2. INDONESIA

4.1.3. MALAYSIA

4.1.4. PHILIPPINES

4.1.5. SINGAPORE

4.1.6. VIETNAM

4.2. REPORT FROM SCSTAC

4.3. REPORT FROM NWPTAC

4.4. REPORT ON SELF-DEVELOPED TSUNAMI DECISION SUPPORTING SYSTEM AT SCSTAC

5. SETTING UP OF BACKUP SCSTAC IN HONG KONG, CHINA

6. FUTURE OF THE TASK TEAM ON THE ESTABLISHMENT OF A SOUTH CHINA SEA TSUNAMI ADVISORY CENTER (TT-SCSTAC)

7. SEISMIC AND SEA LEVEL CORE STATIONS IN THE SOUTH CHINA SEA REGION FOR FURTHER ENHANCING TSUNAMI WARNING CAPABILITY

8. NEXT MEETING

9. ANY OTHER BUSINESS

10. SUMMARY OF DECISIONS, RECOMMENDATIONS AND ACTIONS

11. CLOSE OF MEETING

ANNEX II

ADOPTED RECOMMENDATIONS

Recommendation ICG/PTWS-WG-SCS-X.1

Tsunami Warning and Mitigation System for the South China Sea Region: Sharing of Seismic and Sea Level Stations, Capacity Building, Trial and Full Operation of BSCSTAC, Working Group Governance and Next Meeting

The Regional Working Group on Tsunami Warning and Mitigation System for the South China Sea Region,

Recalling that the Twenty-eighth Session of the Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System (ICG/PTWS-XXVIII) decided to continue the Regional Working Group on Tsunami Warning and Mitigation System in the South China Sea Region (ICG/PTWS-WG-SCS), chaired by Mr Sai-tick Chan from Hong Kong Observatory, China,

Recalling further that the full operation of SCSTAC started on 5 November 2019, as decided by the ICG/PTWS-XXVIII, and also **recalling** that the document "***User's Guide for the South China Sea Tsunami Advisory Center (SCSTAC) products for the South China Sea Tsunami Warning and Mitigation System***" was officially published with an IOC Technical Series No.149 in September 2019,

Recognizes the paucity of seismic and sea level stations close to the major tsunami sources within the SCS region available to Tsunami Service Providers (TSPs);

Encourages the Member States of the WG-SCS to share more seismic and sea level stations to further enhance the tsunami warning capability in the South China Sea region, especially for the Sulu Sea, Celebes Sea and North Borneo;

Agrees to conduct an IOC Training Workshop on Tsunami Forecasting and Risk Assessment for Tsunami Warning Operators, which will include topics on new methods and technologies of seismic data processing and analysis, sea level data processing, tsunami numerical modeling, tsunami forecasting and tsunami risk assessment, in the first week of December 2021 at the kind invitation of SCSTAC/NMEFC, China;

Noting that the purpose of Task Team on the Establishment of a South China Sea Tsunami Advisory Center (TT-SCSTAC) has been largely completed, and the demand to further strengthen capacity development and Services in the South China Sea region,

Recommends dissolving the Task Team on Establishment of a South China Sea Tsunami Advisory Center of the Regional Working Group on Tsunami Warning and Mitigation in the South China Sea;

Further recommends the establishment of a Task Team on Capacity Development and Services with Terms of Reference as in the Appendix to Recommendation ICG/PTWS-WG-SCS-X.1;

Noting that SCSTAC has agreed with the Hong Kong Observatory (HKO) to establish and operate a backup center for SCSTAC at HKO Headquarters, and to develop and operate a backup website of SCSTAC to be hosted by HKO,

Noting further that the backup center will be named as "Backup South China Sea Tsunami Advisory Center (Hong Kong)" [BSCSTAC (Hong Kong)], and satisfactory progress has been made in BSCSTAC to build up backup capability,

Agrees to commence trial operation of BSCSTAC (Hong Kong) in the first quarter of 2022, with specific date to be decided by SCSTAC and announced by the IOC Secretariat to WG-SCS Member States through Circular Letter;

Requests BSCSTAC (Hong Kong) to conduct a communication test with WG-SCS Member States at least one month before commencement of trial operation, with specific date to be decided by SCSTAC and announced by the IOC Secretariat to WG-SCS Member States through Circular Letter at least 30 days in advance;

Agrees to commence full operation of BSCSTAC (Hong Kong) upon satisfactory performance in the trial operation period, with specific date to be decided by SCSTAC and announced by the IOC Secretariat to WG-SCS Member States through Circular Letter;

Recalling that Mr Sai-tick Chan was elected the Chair of WG-SCS at the 27th Session of ICG/PTWS, French Polynesia, 2017, and was re-elected the Chair of WG-SCS at the 28th Session of ICG/PTWS, Nicaragua, 2019,

Supports China’s nomination of Dr Dakui WANG to serve as Chair of WG-SCS in the next intersessional period of ICG/PTWS, and requests WG-SCS Member States to send Vice-Chair nomination for WG-SCS, if any, to the IOC Secretariat before the 29th session of ICG/PTWS;

Noting the prevailing travel restrictions imposed by various countries due to COVID-19,

Welcomes SCSTAC's proposal to continue with the International Staff Programme to host 2 or 3 experts from the Member States of the WG-SCS in 2022 subject to the condition of the COVID-19 pandemic, with the travel and local expenses covered by SCSTAC, and requests the IOC to make the announcement to all Member States’ TNCs and NTWCs of WG-SCS regarding the matter;

Accepts with appreciation the offer of China to keep the possibility of hosting an in-person meeting of ICG/PTWS-WG-SCS-XI in 2022 in Guangzhou, Guangdong Province, China, with dates and venue to be discussed and determined in consultation with the Secretariat and the Chairperson.

Appendix

Terms of Reference

Regional Working Group on Tsunami Warning and Mitigation in the South China Sea Region Task Team on Capacity Development and Services

1. To coordinate training workshops and other technical exchanges on topics related to earthquake and tsunami for enhancing the tsunami warning capabilities of the WG-SCS Member States.

2. To facilitate implementation of the International Staff Programme for short-term secondment of staff from WG-SCS Member States to SCSTAC on an annual basis.

3. To explore ways for furthering the sharing and exchange of relevant data and information in the South China Sea region.

4. To ascertain the latest requirements of WG-SCS Member States for tsunami advisory service provided by SCSTAC.

Membership: Representatives of Member States of the ICG/PTWS WG-SCS (Brunei Darussalam, Cambodia, China, Indonesia, Malaysia, the Philippines, Singapore, Thailand and Vietnam) and invited experts; representatives of PTWC and NWPTAC (JMA); with Chair and Vice-Chair to be elected either by the WG-SCS or the ICG/PTWS.

Recommendation ICG/PTWS-WG-SCS-X.2

ICG/PTWS Governance

Decides to continue the Regional Working Group on Tsunami Warning and Mitigation System in the South China Sea Region. Elected Chair is Dr Dakui WANG (China) with Vice-Chair to be elected. The Terms of Reference for this group remains unchanged;

Decides to dissolve the Task Team on Establishment of a South China Sea Tsunami Advisory Center of the Regional Working Group on Tsunami Warning and Mitigation in the South China Sea noting that the South China Sea Tsunami Advisory Center has been in full operation since November 5th, 2019 and the purpose of the Task Team has been completed successfully;

Decides to establish a Task Team of the Regional Working Group on Tsunami Warning and Mitigation in the South China Sea Region on Capacity Development and Services with Terms of Reference as in the Appendix to Recommendation ICG/PTWS-WG-SCS-X.1. Elected Chair is Mr Zhiguo XU (China) with Vice-Chair to be elected.

ANNEX III

LIST OF PARTICIPANTS

Chair

Mr. Sai-Tick CHAN
Senior Scientific Officer
Geophysics, Time and Marine
Meteorological Services Division
Hong Kong Observatory
134A Nathan Road
Kowloon
Hong Kong SAR China
Tel: +852 2926 8451
Email: stchan@hko.gov.hk

Working Group members

(listed under their country for ease of reference)

BRUNEI DARUSSALAM

Mr. Mohd MATALI
Special Duties Officer II
National Disaster Management Centre (NDMC)
Pusat Pengurusan Bencana Kebangsaan
Jalan Landasan Lama
Berakas, BB3510
Brunei
Email: adeb13@gmail.com

CHINA

Mr. Fujiang YU
Director-General
National Marine Environmental
Forecasting Center (NMEFC)/Ministry of
Natural Resources (MNR)
No.8 Dahuisi Road, Haidian District
Beijing
100081
China
Tel: +861062105732
Email: yufj@nmefc.cn

Mr. Kai-Chun CHEUNG
Scientific Officer
Geophysics, Time and Marine
Meteorological Services Division
Hong Kong Observatory
134A Nathan Road
Kowloon
Hong Kong SAR China
Tel: +852 29268034
Email: johnnycheung@hko.gov.hk

Tingting FAN
National Marine Environmental
Forecasting Center (NMEFC)/Ministry of
Natural Resources (MNR)
No.8 Dahuisi Road, Haidian District
Beijing
100081
China
Email: fantt@nmefc.gov.cn

Mr. Hongwei LI
National Marine Environmental
Forecasting Center (NMEFC)/Ministry of
Natural Resources (MNR)
No.8 Dahuisi Road, Haidian District
Beijing
100081
China
Tel: 0086-010-62104151
Email: lihw@nmefc.gov.cn

Mr. Dakui WANG
Associate Research Professor
National Marine Environmental
Forecasting Center (NMEFC)/Ministry of
Natural Resources (MNR)
No.8 Dahuisi Road, Haidian District
Beijing
100081
China
Tel: +86-10-62105671
Email: dakui.nmefc@gmail.com

Mr. Zongchen WANG
Tsunami Warning Division
National Marine Environmental
Forecasting Center (NMEFC)/Ministry of
Natural Resources (MNR)
No.8 Dahuisi Road, Haidian District
Beijing
100081
China
Tel: +86 10-62104151
Email: wangzc@nmefc.cn

Zhiguo XU
National Marine Environmental Forecasting Center (NMEFC)/Ministry of Natural Resources (MNR)
No.8 Dahuisi Road, Haidian District
Beijing
100081
China
Tel: +86-10 62104561
Email: xuzg@nmefc.cn

Mr. Lianda ZHAO
Scientist
National Marine Environmental Forecasting Center (NMEFC)/Ministry of Natural Resources (MNR)
No.8 Dahuisi Road, Haidian District
Beijing
100081
China
Tel: +861082102752
Email: zld@nmefc.cn

INDONESIA

Dr. KARYONO
Agency for Meteorology Climatology and Geophysics (BMKG)
P.O. Box 3540 Jkt.
Jl. Angkasa I No.2 Kemayoran Jakarta Pusat
DKI Jakarta
10720
Indonesia
Email: karyonosu@gmail.com

Ms. Suci ANUGRAH
Agency for Meteorology Climatology and Geophysics (BMKG)
P.O. Box 3540 Jkt.
Jl. Angkasa I No.2 Kemayoran Jakarta Pusat
DKI Jakarta
10720
Indonesia
Email: sucirahman@yahoo.com

MALAYSIA

Ms. Azahani ABD AZIZ
Meteorologist
Technical Weather and Geophysics
Malaysian Meteorological Department
Jalan Sultan
46667 Petaling Jaya
Selangor
Malaysia
Tel: 0379678225
Email: azahani@met.gov.my

Ms. Zaty Aktar MOKHTAR
Senior Assistant Director
Malaysian Meteorological Department
Jalan Sultan
46667 Petaling Jaya
Selangor
Malaysia
Tel: +60 (03) 7967 8000
Email: ety_nabila@yahoo.com

Mr. Zaidi Bin ZAINAL ABIDIN
Malaysian Meteorological Department Headquarters
Malaysia
Email: zaidi@met.gov.my

PHILIPPINES

Mr. Ishmael NARAG
Supervising Science Research Specialist / Officer-in-Charge
Seismological Observation and Earthquake Prediction Division
Philippine Institute of Volcanology and Seismology
PHIVOLCS Building, C.P. Garcia Avenue
U.P. Campus
Diliman Quezon City
Philippines
Tel: +63 24261468
Email: ishma01@yahoo.com

Ms. Arianne Gail RIVERA
Science Research Specialist - I
Seismological Observation and Earthquake Prediction Division
Philippine Institute of Volcanology and Seismology
PHIVOLCS Building, C.P. Garcia Avenue
U.P. Campus
Diliman Quezon City
Philippines
Email: gail.rivera@phivolcs.dost.gov.ph

Ms. Ma. Mylene VILLEGAS
Chief Science Research Specialist

Geologic Disaster Awareness and Preparedness Division
Philippine Institute of Volcanology and Seismology (PHIVOLCS)†
PHIVOLCS Bldg. C.P. Garcia Avenue, University of the Philippines, Diliman Campus
Quezon City
1101
Philippines
Tel: 63-2 927 45 24
Fax: 63-2 929 83 66
Email: mylene.villegas@phivolcs.dost.gov.ph

SINGAPORE

Mr. Eugene CHONG
Meteorological Service Singapore
PO Box 8 Changi Airport Post Office
Room 048-033, 4th storey, Changi Airport Terminal 2
SINGAPORE 819643
Singapore
Email: chong_wei_ming@nea.gov.sg

THAILAND

Mr. Somneuk SWATTEUK
Special Expert on Early Warning System of National Early Warning Center (NDWC)
Department of Disaster Prevention and Mitigation
3/12 U-Thong Nok Rd, Dusit
Bangkok
10300
Thailand
Email: ss_acdt18@hotmail.com

Mr. Bhumrindra TAUVAROTAMA
Department of Disaster Prevention and Mitigation
3/12 U-Thong Nok Rd, Dusit
Bangkok
10300
Thailand
Email: bhumrindra@gmail.com

VIETNAM

Mr. Xuan Anh NGUYEN
Director
Vietnam Earthquake Information and Tsunami Warning Center, Institute of Geophysics, Vietnam Academy of Science and Technology
18 Hoang Quoc Viet street, Cau Giay District
Hanoi
Vietnam
Email: nxuananh05@gmail.com

Mr. Truyen PHAM
Researcher
Vietnam Earthquake Information and Tsunami Warning Center, Institute of Geophysics, Vietnam Academy of Science and Technology
18 Hoang Quoc Viet street, Cau Giay District
Hanoi
Vietnam
Tel: +84439940320
Fax: +84437914593
Email: ptt502@gmail.com

Observers

Mr. Freddie BLANCO
Programme Officer for Science and Technology
UNESCO National Commission of Philippines
G/F Department of Foreign Affairs Bldg.
2330 Roxaz Boulevard
Pasay City
Philippines
Email: fablanco1966@gmail.com

Mr. Yuji NISHIMAE
Scientific Officer for International Tsunami Information
Japan Meteorological Agency
3-6-9 Toranomon, Minato City, Tokyo 105-8431, Japan
Japan
Tel: +81 (3) 6758 3900
Email: nishimae@met.kishou.go.jp

Secretariat

Mr Bernardo ALIAGA ROSSEL
Programme Specialist, Tsunami Unit
Intergovernmental Oceanographic Commission of UNESCO
7 Place de Fontenoy

75732 Paris Cedex 07, France
Tel: +33 1 45 68 03 17
Fax: +33 1 45 68 50 10
Email: b.aliaga@unesco.org

Ms Esmeralda Aline BORJA
Project Assistant, Tsunami Unit
Intergovernmental Oceanographic
Commission of UNESCO
7 Place de Fontenoy
75732 Paris Cedex 07, France
Tel: +33 1 45 68 10 68
Email: e.borja-aviles@unesco.org

Ms Celine TIFFAY
Tsunami Unit
Intergovernmental Oceanographic
Commission of UNESCO
7, place de Fontenoy
75732 Paris cedex 07
France
Email: c.tiffay@unesco.org


Celine Tiffay TSU/SEC
Esmeralda Borja IOC/T...
Bernardo Aliaga
Sai-tick CHAN
xuzhg
China-Dakui WANG
PH_Gail Rivera
Nishimae (Japan)
KI
Karyono-Indonesia
STC
Sai-tick CHAN
PH_Ishmael Narag
Truyen The Pham - VN
Suci Dewi Anugrah_IN...
MMD
ACM Somneuk NDWC ...
JCKC
Johnny CHEUNG Kai C...
CHINA
PH_Mylene Villegas
Eugene (MSS)
TTPV
Truyen The Pham-VN
Johnny Cheung Kai Ch...

ANNEX IV

LIST OF ACRONYMS

BIG	Agency of Geospatial Information
BMKG	Agency for Meteorology Climatology and Geophysics
CEA	China Earthquake Administration
DSS	Decision Supporting System
EQFS	Earthquake Field School
HKO	Hong Kong Observatory
ICG	Intergovernmental Coordination Group
IGP	Institute of Geophysics
InaTEWS	Indonesia Tsunami Early Warning System
IOC	Intergovernmental Oceanographic Commission
IOTIC	Indian Ocean Tsunami Information Center
ITIC	International Tsunami Information Center
ITST	International Tsunami Survey Team
JMA	Japan Meteorological Agency
LDMO	Local Disaster Management Office
MMD	Malaysian Meteorological Department
MSS	Meteorological Service Singapore
NDMO	National Disaster Management Office
NMEFC	National Marine Environmental Forecasting Centre
NTWC	National Tsunami Warning Centre
NTWS	National Tsunami Warning System
NWPTAC	Northwest Pacific Tsunami Advisory Center
PHIVOLCS	Philippine Institute of Volcanology and Seismology
PSN	Philippine Seismic Network
PTWC	Pacific Tsunami Warning Center
QEM	Quick Earthquake Message

SCS	South China Sea
SCSTAC	South China Sea Tsunami Advisory Centre
SCS-WG	Regional Working Group on Tsunami Warning and Mitigation System in the South China Sea Region
SMS	Short Message System
SOP	Standard Operating Procedure
TEMPP	Tsunami Evacuation Map, Plans and Procedures
TIC	Tsunami Information Centre
TSP	Tsunami Service Provider
TT-SCSTAC	South China Sea Tsunami Advisory Center Task Team
UNESCO	United Nations Educational, Scientific and Cultural Organization
VAST	Viet Nam Academy of Science and Technology
WFH	Work From Home
WRS	Warning Receiver System