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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)

Ninth Meeting (online)

27–28 August 2020

UNESCO

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ANNEXES

V. LIST OF ACRONYMS

1. WELCOME AND OPENING

The Ninth session of the Pacific Tsunami Warning and Mitigation System Regional Working Group on Tsunami Warning and Mitigation System for the South China Sea Region (SCS-WG-IX) was held online from 27 to 28 August 2020.

Mr Sai-Tick Chan, Chairperson of the SCS-WG and Senior Scientific Officer of the Hong Kong Observatory (HKO), welcomed all participants to the meeting and thanked the IOC Secretariat for arranging and hosting the online meeting of the group.

2. ORGANIZATION OF THE SESSION

2.1 ADOPTION OF AGENDA

Chair Sai-Tick Chan recalled that the meeting was attended by representatives from China, Indonesia, Malaysia, the Philippines, Singapore and Viet Nam, as well as invited representative from the Japan Meteorological Agency (JMA) and the Pacific Tsunami Warning Center (PTWC). 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 -IX online meeting website.

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

The South China Sea Region Tsunami Warning System: Seismic and Sea Level Core Stations, Full Operation of SCSTAC, Capacity Building and Next Meeting.

Agrees with the proposal of China which volunteered and nominated Dr Dakui WANG to serve as inter-sessional contact point to communicate with individual Member States of the WG-SCS regarding the arrangement for sharing more seismic & sea level stations to further enhance the tsunami warning capability in the SCS region, especially for Sulu Sea, Celebes Seas and North Borneo.

Action taken: Member States encouraged to contribute more data internationally, or to the SCS Seismic & Sea Level Data Exchange Server operated by SCSTAC aiming to reduce detection latency of tsunamigenic events, especially for Sulu Sea & Celebes Seas. Dr Dakui Wang/China was designated by WG-SCS as the focal point to communicate with Member States on the matter. Discussion met with positive responses from individual Member States (Indonesia, Malaysia). In particular, Indonesia provided the URL for sharing more sea level data and the URL for obtaining the 21 seismic station data from seedlink server of GEOFON.

Requests SCSTAC to continue to generate quarterly reports on seismic and sea level core stations in the SCS region, including the percentage of availability of core stations, data availability and latency, and detection performance based on the up-to-date seismic and sea level networks contributed by Member States, and make available the reports on SCSTAC website for reference by Member States.

Action taken: SCSTAC generates statistics on data availability of seismic and sea level stations and presents them on SCSTAC website (www.scstac.org) on a quarterly basis.

Agrees to conduct an IOC Training Workshop on enhancing the capacity of observation in SCS region, which will include a specific topic on seismic data exchange using the dedicated Seedlink server of SCSTAC, on 21-25 October 2019 in Hangzhou, China.

Action taken: IOC training for seismic and sea level operators: enhancing the capacity of tsunami observation and data sharing in the South China Sea region, 21 - 25 October 2019, was organized by NMEFC in Hangzhou, China. There were twenty-one participants from China, Brunei, Indonesia, the Philippines, Malaysia & Vietnam. The objectives of the workshop were: Workflow, methodologies & tools for seismic and sea level observation; promotion of regional data sharing.

Welcomes SCSTAC's proposal to continue with International Staff Programme to host two experts from Member States of the SCS-WG in 2019, with travel and local expenses covered by SCSTAC.

Action taken: International Staff Programme - Secondment of 3 short-term international staff from Malaysia, the Philippines & Vietnam to SCSTAC was organized during 16 Sep – 15 Nov 2019.

Agrees to conduct a training workshop on strengthening SOPs and use of ICG/PTWS SCSTAC advisory products in 2020 in China with the venue and date to be confirmed in due course.

Action taken: Owing to spread of COVID-19, workshop would be postponed to 2021 subject to availability of funding.

Decides to submit the proposal to the 28th ICG/PTWS session, on the full operation of SCSTAC in the second half of 2019 as in Annex to this recommendation.

Action taken: The proposal was endorsed at the 30th Session of IOC Assembly, supporting the full operation of SCTAC. Full Operation commenced on 5 November 2019.

Other Actions: User's Guide for SCSTAC products was published in September 2019 with details about SCSTAC products, geographical coverage, bulletins, forecast points and other technical aspects.

Requests SCSTAC to finalize the arrangements on consistency of earthquake parameters in consultation with NWPTAC and PTWC before the full operation of SCSTAC.

Action taken: Further discussion was made among SCSTAC, PTWC & NWPTAC on ensuring consistency of earthquake parameters in September 2019. Buffer zone was introduced for which Tsunami Service Providers (TSPs) can use own earthquake parameters to issue tsunami bulletins.

Requests the ICG/PTWS to instruct potential arrangements among PTWC, NWPTAC and SCSTAC for the consistency of the format of tsunami bulletins.

Action taken: Chair of WG-SCS joined the agenda item on harmonization of format and content of TSP operational products across ICGs & TSPs of Meeting of TOWS WG Inter- ICG Task Team on Tsunami Watch Operations (TTTWO) on 19 February 2020. Acknowledging that harmonization of products across all TSPs would be a daunting task, the Task Team noted the importance of CAP for provision of harmonized tsunami warnings and would further consider the suggestion taking into account the initial work being pursued by ICG/IOTWMS (re. Section 12.0, meeting report of TTTWO).

Agrees and supports the holding of regular communication tests four times a year by SCSTAC, at the start of each quarter tentatively with prior notice given by IOC Secretariat, following its full operation, and requests all WG-SCS Member States to regularly update their contact information with IOC Secretariat following the established procedures.

Action taken: Regular communication tests via GTS (WESS31 BABJ), email & fax were being conducted 4 times a year: 1st on 13 Jan 2020 and 2nd delayed due to COVID-1, was conducted on 8 Jun 2020.

Agrees to continue the work of TT-SCSTAC in the next inter-sessional period of ICG/PWTS, with revised Terms of Reference and Dr Ye Yuan of China serving as Chair. Supports China's nomination of Mr Sai-Tick Chan to continue serving as Chair of WG-SCS in the next intersessional period of ICG/PTWS, and requests WGSCS Member States to send Vice-Chair nomination for WG-SCS to IOC Secretariat.

Action taken: Mr Sai-tick Chan & Dr Ye Yuan were re-elected chair of WG-SCS & TT-SCSTAC, with Vice-Chair remaining as vacant at the 28th ICG/PTWS Session held in Barcelo Montelimar, Nicaragua during 2-5 April 2019.

Accepts the offer of China to host WG-SCS-IX in 2020.

Action taken: WG-SCS-IX could not be held as planned in March 2020 in Guangzhou, China due to spread of COVID-19. This online session was convened to keep the momentum of the work of WG-SCS. China is willing to resume the WG-SCS-IX in January 2021, noting the uncertainty about the COVID-19 development and the 29th Session of ICG/PTWS supposed to be held in Japan next year.

Apart from matters arising from ICG/PTWS-WG-SCS-VIII Meeting, the Chair also informed the meeting that the PTWS Steering Committee had hosted its biennial intersessional meeting online on 16-18 June 2020. Two major decisions made by the meeting were:

(1) With respect to PacWave20, the Steering Committee reiterated the difficulty of conducting the exercise as planned given the prevailing COVID-19 situation, and recommended that a reduced scale of PacWave20 be carried out, namely, TSP-to-TWFP communication test to be conducted on November 5, 2020, and CATAC (Central American Tsunami Advisory Center) to proceed with the regional exercise. Other activities were encouraged but were at the discretion of the Member States.

(2) With respect to PTWS XXIX, the Steering Committee agreed to support the plan suggested by Japan, requesting Japan and the IOC Secretariat to work on the alternatives of hosting of PTWS XXIX including: (a) meeting to take place as originally presented by Japan on 13-14 and 15-18 March, 2021; (b) semi-presential (reduced number of participants) meeting combined with an online meeting; and, (c) postponement of the in-person meeting for later in 2021 and further decision would be made at next on-line meeting in September 2020. The Steering Committee recommended that online participation be considered in all options, considering the potential budgetary and travel limitations for the Member States.

4. REPORTS

4.1 NATIONAL PROGRESS REPORTS

4.1.1 China

Dr Ye Yuan, National Marine Environmental Forecasting Centre (NMEFC), Ministry of Natural Resources of the People's Republic of China, presented the report of China. He reported on earthquake detecting and sea level monitoring capability. For sea level, the global and regional monitoring network in China consist of GTS and IOC Sea Level Monitoring Stations Facility (SLMSF) data. In China, 120 tidal gauges are available along the Chinese coast and the deployment of a third tsunami buoy is being planned.

For the Tsunami Warning Technologies and Dissemination, they have two sets of tsunami database: one covers the western North Pacifc with about 70,000 scenarios and more than 1,600 sources and the other cover the whole Pacific Ocean with about 2,000 unit sources.

On-the-fly tsunami forecast model run on GPU was capable of accomplishing a Pacific tsunami forecast within 45 seconds, 135 times faster than the serial version. The model was validated by 9 major historical tsunamis induced by submarine earthquakes with Mw more than 8.0 in the Pacific region since 2006 with abundant observations. Forecasting accuracy of threat levels was acceptable in terms of tsunami warning purpose, with 80% of results falling into the corresponding levels.

NMEFC has also done some research on volcanic tsunami for which they use a Nonlinear two-layer pyroclastic flow model. The Decision Supporting System (DSS) at NTWC operated stably and smoothly. Furthermore, NMEFC was developing an English version to share it with other Member States. Another DSS based on Web-GIS was developed for local tsunami emergency response agencies.

Dissemination is automated as much as possible to facilitate the widely covering issuance of tsunami messages effectively and efficiently. Dissemination channels includes fax, email, broadcast and TV, website, SMS and lately social media. The website of the NTWC is now operational and the public user can access bulletins, historical messages and education materials while the local decision makers and the regional stakeholders has full access to the focal mechanism, rupture process and sea level data. NMEFC also started the operation of the SCSTAC website where public users can access text products and historical bulletins while National Tsunami Warning Centres (NTWCs), Tsunami Warning Focal Points (TWFPs) and Other TSPs have full access to the graphical products, focal mechanism and sea level data.

NMEFC has responded to 41 major earthquakes with magnitude greater than 6.5, they issued 77 tsunami information bulletins to relevant agencies and stakeholders, with average latency of 9.6 minutes for the first message.

In terms of international cooperation and activities, NMEFC participated in the Eighth Meeting of the ICG/PTWS Regional Working Group on Tsunami Warning and Mitigation System in the South China Sea Region, held in Jakarta, Indonesia, from 4 to 6 March 2019, and in the Twenty-eighth Session of the Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System (ICG/PTWS-XXVIII) from 2 to 5 April 2019 in Nicaragua. Dr. Karyono from the Indonesian Meteorological, Climate and Geophysical Bureau (BMKG) visited SCSTAC and spent one week to communicate on Tsunami Warning System, especially on Decision Supporting System.

NMEFC also received the visit of a delegation of the Hydrographic and Oceanographic Service of the Chilean Navy (SHOA) to exchange about technical issues. They expected to host the visit of experts from other Member States in the coming years. NMEFC participated in the Antelope Users Group Meeting in Calgary, held in Alberta, Canada from the 15th to 19th September 2019.

China also hosted the IOC South China Sea training for seismic and sea level operators with an ami to enhance the capacity of tsunami observation and data sharing in the South China Sea region, in Hangzhou, China from the 21 to 25 October 2019,

4.1.2 Indonesia

Dr Karyono, Dr Daryono and Ms Suci Dewi Anugrah, Government Officers, Earthquake and Tsunami Mitigation Subdivision, Agency for Meteorology, Climatology and Geophysics (BMKG), on behalf of Mr Rahmat Triyono, Director of Earthquake and Tsunami Centre of Indonesia, which hosts the Indonesia Tsunami Early Warning System (InaTEWS), reported on the status of InaTEWS. Dr Karyono reminded that Indonesia Region is part of what is called the “ring of fire”, a very seismic active region in the world. He explained that the Indonesian seismic activities tended to increase since 2013 in both frequency and intensity. The increase in seismic activities frequency was not related to the additional sensor installation since the network was added in 2019. The significant earthquake number in 2018 and 2019 was related to some significant events in 2018 (Lombok (2763 aftershocks), Palu (1438 aftershocks)).

He explained that 46% of Indonesia’s coastal length is prone to tsunami, so the Indonesia Tsunami Early Warning System was stablished in November 2008with the goal to provide timely detention of earthquake events and provide tsunami warnings to the responsible institutions and people.

In terms of monitory systems until February 2020, INATEWS comprised 372 seismic stations distributed around Indonesian area. In order to improve the quality of earthquakes barometer, they also received the data exchange from other countries like Germany, Japan China, USA, Australia and CTBTO. There were existing plans to add 100 new seismic station in the coming years.

For seismic processing, Indonesia counted on the Seiscomp3 application that could operate in automatic and manual mode by the operator on duty. They could also determine the focal mechanism in real time. Talking about tsunami processing, INATEWS had 18,000 tsunami scenarios. The tsunami modeling could get the input of the focal mechanism in real time, which can increase the quality of modelling.

INATEWS main system was located in Jakarta and the backup system was located in Bali; BMKG also had a training system to make sure that the operators are capable to understand the system and keep it operating.

Indonesia reported that for dissemination the simple flowchart of dissemination system actually came from seiscomp3. They first run the tsunami modeling and then by using the dissemination engine (DSM engine), the operator activates the system and the information will go to the multimodal dissemination system including SMS, email, WRS, web and others. A new generation of the warning receiver system was deployed in 2020, with new features mandates, that basically could get the alarm and information in real time. It could also manage SMS and forward it to different groups.

In terms of global collaboration, Indonesia served as Tsunami Services Provider TSP for the Indian Ocean, ASEAN Earthquake Information Center and as NTWC for the Indian Ocean, Pacific and South China Sea (SCS) area. It had also identified areas of cooperation with SCS, not only in seismic data exchange, but also in joint research and technical skills exchange. It would be beneficial if an agreement for future cooperation with SCS could be set up.

For capacity building, Indonesia offered formal degree courses for training of staff and started to deploy the Decision Support System with SL-3, as well as carrying out other outreach activities.

4.1.3 Philippines

Mr Ishmael Narag, from the Philippine Institute of Volcanology and Seismology (PHIVOLCS), presented the report of Philippines. He reported the experiences in the Philippines during the time of COVID-19 pandemic, where an inter-agency task force was established to provide policy directions to different provinces.

The seismic monitoring done in this period showed that they had around 7,000 events from the 1st March to August 16th, 2020 detected by 104 seismic stations. On August 18th, 2020 a 6.6 Mw event took place in Mabate Island in the central part of the Philippines, located near the very populated areas.

During this period, PHIVOLCS issued several seismic information products, covering local events, earthquake events which had significant magnitude values but fortunately were deep and did not generate tsunamis.

During this period, PHIVOLCS reported:

1. Management of earthquake and tsunami monitoring systems during the declaration of a national health emergency:

    - PHIVOLCS adapted new office protocols to follow health protocols set by the Inter-Agency Task Force (IATF) for COVID-19 Pandemic. Modified working arrangements and updates were made through online meetings. In-house skeletal workforce during enhanced community quarantine period and work-from-home arrangements with connectivity were established. Emergency funds supported all monitoring activities, transportation of skeletal workforce was provided and also a provision of hazard allowance.

2. Maintenance of earthquake and tsunami monitoring systems:

    - Corrective and preventive maintenance of monitoring and communication equipment was performed by nearest technical staff or by the local government partners

3. Staff performance and project deliverables:

- Even when in general project deliverables have been delayed by the sanitary situation, there has been several learning and development activities for work-from-home staff related to institutional goals, especially focused on capacity building on technical and leadership skills. Online training on Tidal Analysis Software Kit (TASK) was also conducted.

Some areas of opportunity had been identified by PHIVOLCS where it would kindly request the support of SCSTAC:

1. Continued timely provision of tsunami advisories and product

2. Online courses on various topics related to earthquakes and tsunami, such as seismic data processing, earthquake and sea-level monitoring, tsunami propagation and inundation modelling and other technical skills like computer programming

3. Quarterly meetings with regional member

4. Perform regional tsunami exercises

4.1.4 Singapore

Ms Weilin Hu, Senior Meteorologist, Meteorological Service Singapore (MSS), presented the report of Singapore. Singapore's report mainly shared about the roles and responsibilities in seismic monitoring, seismicity around Singapore and the potential impact of seismic events on Singapore.

MSS monitors seismic events in the region to assess potential impact of a tsunami in Singapore. MSS is part of the National Inter-Agency Tsunami Task Force which main role is to coordinate the responses of agencies. In case of a tsunami event, MSS provides early warning and activate response mechanisms: MSS notifies of significant earthquakes, provides assessment of impact if there is risk of tsunami affecting Singapore and informs of seismic events (location of earthquake and magnitude) with assessment even if there is no impact to Singapore.

To enhance the monitoring assessment activities in the region, MSS upgraded its monitoring system to the SeisComP3 in July 2019. In addition, it operationalized out tsunami summation terminal (TOST) which was integrated to SeisComp, also in 2019. The new capabilities enabled MSS to assess the risk of tsunami risk more quicky and to get the estimated time of arrival more quicky. MSS also received and used bulletins issued by others tsunami services providers, such as PTWC, NWPTAC, SCSTAC, RTSPs (India, Indonesia, Australia).

Upon detection of earthquake with tsunami-genic potential, MSS issues an "Earthquake Alert" with advisory message on possible tsunami, the tsunami Alerts are disseminated to response agencies and for wider reach, information is also available on the website and mobile app. Further "Tsunami Alerts" will be issued when MSS receives data confirming presence of ocean wide tsunami.

In terms of Potential Impact of seismic events on Singapore, in the region MSS originally received alerts of surface waves generated by earthquakes along Sumatra Fault or Sunda Trench, so on average 1 to 2 events associated to earthquakes in the region are reported per year. Singapore university studies had identified two seismic zones where large undersea earthquakes could potentially generate oceanwide tsunami that might affect Singapore. The two zones are Sunda Arc and the Manila Trench. The studies showed that the

tsunamis generated in these two zones might bring wave height of up to 1 metre in Singapore and they were supposed to reach Singapore in 10-12 hours.

4.1.5 Viet Nam

Mr Pham The Truyen from the Institute of Geophysics (IGP) within the Viet Nam Academy of Science and Technology (VAST), presented the report of Viet Nam. He indicated that the Vietnam Earthquake Information and Tsunami Warning Centre under the Institute of Geophysics was established since 2007.The Vietnam Seismic Network (VSN) consisted of 31 broadband seismometers.

Recently in Vietnam, several earthquake events were recorded in different parts in the north of Vietnam, which were followed by deployment of portable seismic stations to survey the zones:

- Cao Bang Earthquake 25/11/2019 - To deploy seismic stations and carry out a field survey of the earthquake M = 5.0 dated 25/11/2019 in Cao Bang province
- Lai Chau Earthquake 25/11/2019 - To deploy seismic stations and carry out a field survey of the earthquake M = 4.9 dated 16/6/2020 in Lai Chau province
- Son La Earthquake 27/07/2020 - To deploy seismic stations and carry out a field survey of the earthquake M = 5.1 dated 27/7/2020 in Sơn La province

Along with the seismic network Vietnam also operated the national sea level network, with tide gauges along the cost of Vietnam. Some of the tide gauges sent data directly to the Tsunami Warning Center. Besides the data from the National Sea Level Network, IGP also got the data from other countries like China and Indonesia.

With respect to the seismic network of Vietnam, IGP recorded the data and sent it directly to the earthquake information and tsunami warning where it used Seiscomp3 to process the data. If the event reached a magnitude of 6.5 Mw, IGP would check the sea level data and issue a warning.

With respect to ongoing activities, Mr The Truyen reported that they had recently revised the national natural disaster scale for earthquake and tsunami and upgraded the tsunami scenario database for warning purpose (COMCOT model used). Beside this, they started a national project on “Natural risk zoning and establishment of earthquake and tsunami warning maps” that will be carried out over three to five years.

4.2 REPORT FROM SCSTAC

Dr Yuan Ye (NMFEC) presented a report on operations of the South China Sea Tsunami Advisory Center (SCSTAC). He recalled that the ICG/PTWS at its 27th session (ICG/PTWS-XXVIII) decided to commence the full operation of SCSTAC on 5 November 2019, to be announced by the IOC Secretariat to SCS-WG Member States through Circular Letter at least 60 days in advance. Dr. Vladimir Ryabinin, ADG of IOC/UNESCO addressed the ceremony and Mr. Mok (former SCS-WG chair) and the Administrator of SOA/MNR attended the event.

Dr Yuan provided a detailed report on the SCSTAC status. In terms of staffing, the Center was being manned by 13 watch standers, including 2 chief scientists. COVID-19 impact caused no significant impact to the Centre’s operations, though in-person outreach activities had been put on hold and had been replaced with on-line activities. Sea level monitoring was enhanced in Sulawesi, with support provided by BMKG. The China Earthquake Administration

(CEA) seismic network had been stable and not affected by COVID-19. With respect to dissemination, Dr Yuan remarked that they had added GTS and now they included website, GTS, email, and fax as dissemination channels.

Based on the seismological networks from IRIS, GEOFON and GEOSCOPE DMC, data from a total of 116 seismic stations were available to the SCSTAC within and surrounding the SCS region.

There had been fourteen earthquakes with M>=6.0 in the SCS region from January 2019 to August 2020, many of which occurred in the Molucca sea. The response time for initial bulletins from SCSTAC was generally within 6-12 minutes, with an average of 7.8 minutes.

Dr. Yuan also kept track of the performance of preliminary earthquake parameters (hypocenter location/magnitude and depth) of SCSTAC compared with USGS final bulletin. Location deviation was in general within 40 km, magnitude deviation around 0.5, with a RMS error of ±0.21. The maximum depth deviation was ~50km, RMS error = ±24km.

In terms of communications test, Dr Yuan reported on two communication tests: the first one on January 14h, 2020, with responses from 7 out of 9 SCS Member States, HKO, NWPTAC, Japan, PTWC, US and Meteo France (non-Member States). The second test was planned for April 2020, but due to the COVID-19 pandemic it had to be rescheduled for June 2020, when SCSTAC received responses of 7 out of 9 SCS Member States, HKO, NWPTAC, Japan, Morocco and England (non-Member States).

For the latency of all the data received during the exercises, GPS and email were considered the best dissemination mechanism because the latency was four minutes only for the GPS in the first exercise and two minutes for the second. SYSTAC could use the email and GPS for a stable transmission of the message. For the fax, it was found that at least one-third of the fax numbers were not effective or functional, some of them might indeed be wrong numbers.

Dr. Yuan presented a comparison of notable issues for the operations in 2019 and 2020. The first one was that density of the seismic network was not enough. SCSTAC identified large errors in the location and the magnitude due to the sparse network.

Another issue found was that SCSTAC website service had been unstable, which did not update automatically due to unknown issues. SCSTAC's IT service was asked to investigate into the problem and they found that the problem was with the code of the website, along with some cyber-attacks. SCSTAC considered that the web service should need to be upgraded to ensure stability.

The tsunami scenario database was deemed to be another important issue, which was not complete in Molucca Sea, a situation that SCSTAC was not aware of before the occurrence of the Mw 7.1 earthquake event in the Northern Molucca Sea on 14 November 2019. The watch stander then noticed the missing scenarios in the Molucca Sea, and the initial bulletin could only be issued 15 minutes after the initial earthquake, as they needed to use other methods to generate the required parameters.

Dr Yuan also reported on the ongoing works of SCSTAC. The first one was the extension of tsunami warning SOP for earthquakes outside the SCS Area of Service, in response to the request of the PTWS Steering Committee that suggested TSPs to respond to all events that might have tsunami potential in their own service areas. SCSTAC was working

on development of real-time tsunami models for the western North Pacific and the whole Pacific Ocean, and tsunami warning capability based on the Unit Sources in Pacific-wide subduction zones.

Another aspect SCSTAC was working on was the development of Python-based Tsunami Warning Decision Supporting System (DSS), as a backup at SCSTAC and to help SCS Member States agencies which might require a DSS (open source code) for their domestic warning. The main module would include earthquakes parameter collection; tsunami scenario database; real-time numerical model and sea level monitoring. In this context, Dr Yuan further remarked that SCSTAC had been working with HKO to establish a backup centre in Hong Kong, to cater in case of malfunctioning of the primary Center in Beijing.

Dr. Yuan informed the meeting that SCSTAC hold a second short-term SCS Regional staff programme with the assistance of 3 staff from Indonesia, Malaysia, and Vietnam that lasted for two months in 2019. They also hosted the IOC SCS training for seismic and sea level operators in Hangzhou, China, from the 21 to 25 October 2019. The purpose of the training was to work on methodologies, software and operations on seismic and sea level observation in a TWC for promotion of regional data sharing. Trainees from Indonesia, the Philippines, Malaysia, Vietnam, Brunei and China (including HKO) had participated in the training.

SCSTAC also received visitors from the Earthquake and Tsunami Center of BMKG Indonesia and the SHOA Director Rear Admiral Patricio Carrasco which were both very fruitful. SCTAC looked forward to further enhancing the cooperation between agencies.

4.3 REPORT FROM NWPTAC

Mr Yuji Nishimae, Scientific Officer in the International Tsunami Information Section of Earthquake and Tsunami Observation Division of Japan Meteorological Agency (JMA), presented its report.

The report covered the activities of the NWPTAC since the previous working group meeting from April 2019 to August 2020. In February 2019, NWPTAC started to issue the enhanced products, including graphics as well as full operations (information of 19 events). In July 2019, NWTAC ran a communications test.

Mr. Nishimae informed that by November 2019, NWPTAC terminated the interim service provided to the South China Sea region as the SCSTAC started its full operation. At the same time, the Area of Services (AoS) was amended according and the number of recipient countries had decreased from 16 to 10.

In terms of Earthquake Source Zone (ESZ) and buffer zones, Mr Nishimae recalled that PTWC, SCSTAC and NWPTAC made arrangements for the consistency of earthquake parameters among the TSPs. This was done to address the issue that if an earthquake occurred near the boundary between both centers' ESZs and both centers decided that the earthquake had occurred in the area of the other center, it could be possible that no information would be announced by either centers.

Mr Nishimae reported that NWPTAC conducted communications tests basically twice a year since 2012. Thanks to the coordination of the IOC Secretariat and the Member States, the situation seemed to be becoming better in terms of responsiveness of focal points.

4.4 STRUCTURE AND FUNCTIONS OF SELF-DEVELOPED TSUNAMI DECISION SUPPORTING SYSTEM AT SCSTAC

Mr Hongwei Li (NMEFC) presented a report on structure and functions of the self-developed decision supporting system at SCSTAC. He recalled the importance of having a well-designed DSS that could save several minutes for issuance of a tsunami warning. He noted the limitation in the maintenance of the original system, as it was difficult to change the DSS for relatively minor SOP changes.

NMEFC decided to develop an in-house DSS that would be suitable for its SOP and friendly to users as well, built with an open code sources (Python) for users to adapt when required. He indicated that the DSS would divided in two modules: Tide Data Module and EQ Data Module.

The EQ Monitoring sub-module under the EQ Data Module would acquire earthquake data from local earthquake system (e.g. Seiscomp3, Antelope) and from earthquake monitoring agencies including USGS or JMA. It would also allow users to do some current operation on each crawling thread.

The sub-module on Information Display would show the static information on map (city, forecast region), it would also show dynamic information (earthquake location, forecast result) and allow users to do some interactions.

The EQ analysis sub-module would outline all the earthquake events obtained from local and other agencies and their parameters (basic parameters and focal mechanism, if available). The preferred origin could be set, and it would allow change of parameters based on historical events, manual insertion of events to perform exercises, and plot earthquake location map and show tectonic information.

The Tsunami Forecast sub-module would compute tsunami travel time of selected earthquakes and also the maximum tsunami height along selected coastal areas (scenario database or on the fly simulation). It would also plot tsunami forecast maps in the forecast area and show the steps of SOP for checking by the user (e.g. products yet to complete and steps already done, etc.).

The Tide Observation sib-module would display the tide data crawled from internet, indicating the data quality for each station by color scales. It would also allow interaction with the tide data to select the maximum tsunami height and other relevant information.

Tsunami bulletins could be generated in the Bulletin Generation sub-module by selecting the relevant product template based on earthquake information. It would generate the products quickly (doc, txt, html) and it could be configurated to send the information through email, website or SMS.

As the project was in the beginning stage, Mr Li noted that there would still a lot of work to do (debugging, system optimization, and continual improvement). He indicated that they were seeking opportunities to collaborate with other Member States to develop this Python-based DSS, with the purpose of helping them to enhance national-level tsunami warning capability.

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

Dr Ye Yuan (NMEFC) presented a report on continuous rate of seismic and sea level data contributed by the SCS-WG Member States, with a summary of availability of seismic stations and sea level stations through quarterly statistics since the second quarter of 2019. In total, they have monitored 51 stations. The distribution of the seismic networks was uneven with only 23 out of the 51 stations having continuous rate above 90%. This showed that the analysis results and response time would not very satisfactory for tsunami-prone areas in the SCS region.

Dr Yuan informed that they tested the public accessibility of tide gages by GTS and through the IOC Sea Level Station Monitoring Facility portal (17 stations) and noted that the number of stations accessible by SCSTAC was 32. This was the result of the contribution by BMKG Indonesia through the BIG Web Portal to assist SCSTAC in monitoring sea level in the Sulawesi Sea. With this, the average time latency would be less than 10 minutes and for 7 out of 17 stations the continuous rate was above 80%.

Dr. Yuan mentioned as notable issues that data continuous rate was not stable, seismic and sea Level monitoring gaps existed in tsunami-prone areas and currently there was no tsunami buoy in service within the area.

The chair noted that Dr Dakui Wang from China was serving as focal point from SCSTAC to communicate with the Members States on the data sharing issue. He invited Dr Wang to continue with this communication during the intersectional period.

The Secretariat inquired if online training dedicated to sea level or seismic operators could be explored to increase the exchange of data between Member States. Mr. Yuan recalled the success of the last event conducted in Hangzhou, and the fruitful discussion held between the participants regarding data sharing and the connection that had been established subsequently. He mentioned that Dr Wang mentioned the possibility of hosting online trainings as no one had any certitude with the pandemic.

Chair Sai-Tick Chan recalled that in terms of data sharing between the Member States, Indonesia also mentioned the need to set up an agreement between Member States or bilaterally with SCSTAC and encouraged Dr Wang to pursue and also to continue the discussion with Malaysia about sharing more data.

6. ADVISORIES ISSUED BY TSPs FOR EARTHQUAKES THAT OCCUR OUTSIDE AREA OF SERVICE BUT POSE THREAT TO MEMBERS

Dr Charles McCreery (PTWC) recalled the global coverage by Tsunami Service Providers (TSPs) and provided a brief introduction of the TOWS-WG approved rules for the Application of Area of Earthquake Responsibility (AER) and its application in the South China Sea region:

1. If the earthquake is located by a TSP inside its AER, then it should issue its product immediately.

2. If the earthquake is located by a TSP outside its AER but within the buffer zone, it should check if the authoritative TSP has issued a product first.

    - If it has, then copy its earthquake parameters.

- If not, then issue its own product immediately

3. If the earthquake is located outside of its AER and outside of the buffer zone but still within its Earthquake Source Zone (ESZ), then if no product has been within 10 minutes from the authoritative TSP then it could issue products with its own earthquake parameters.

Dr McCreery recalled that TOWS-WG Task Team on Tsunami Watch Operations recommended this procedure to eliminate the possibility of no product being issued promptly for an event near a border when both TSPs judged it was in the other TSP's AER.

Dr. Yuan (SCSTAC) provided a presentation and expressed his agreement for the Area of Service and the Area of Earthquake Responsibility, however for the area of Earthquake Source Zone he recommended more caution.

Mr Nishimae (NWPTAC) presented about the PTWS ESZs and Area of Service (AoS) of NWPATC and SCSTAC. He recalled that in case of an earthquake near the boundary of the two AER of PTWC, SCSTAC and NWPTAC, the same source parameters for the first bulletin would generally be used. PTWC, SCSTAC and NWPTAC made arrangements for the consistency of Earthquake Parameters among the TSPs.

If an earthquake occurred near the boundary between the two AER and both centers decided that the earthquake occurred in the area of the other center, there will be a concern that no information would be announced from either center.

Both centers had defined areas called the Buffer Zone with 100 km width from boundaries of the AER. When the epicenter was analysed to be within in the Buffer Zones, both centers would individually issue their information using their own source parameters.

He focused his presentation on the case of a large earthquake far from the AoS, namely, an earthquake near the southern Chile coast. In that case, it would take more than 10 hours to arrive at the AoS. The PTWC would issue the first bulletin in about 10 minutes and the second bulletin in 40 to 50 minutes following the event. The second bulletin of the PTWC included estimated tsunami heights at coasts.

For such a case, recipient countries could adequately take counter measures against tsunami using the PTWC's second bulletin. Mr Nishimae (NWPTAC) questioned if it was necessary that both NWPTAC and the SCSTAC issue tsunami information for a big earthquake far from their AoS like the 1960 Chile earthquake? And if harmonizing the regional TSP's AER among NWPTAC, SCSTAC, and CATAC would be useful for the recipient countries?

With this in mind, NWPTAC proposed a discussion on issuance of tsunami information from a regional TSP for an earthquake occurring outside the AoS:

- Considering regional TSP's responsibility, should it be reasonable to limit the AERs?

- Would harmonizing the regional TSP's AERs among PTWC, NWPTAC, SCSTAC, and CATAC be useful for the recipient countries?

- Should TSPs describe their AER and procedures and timing of their information in their users' guides in order to avoid confusion of recipient countries?

Mr Nishimae suggested TSPs to continue discussion on the matter and to report back to the next session. Chair Sai-tick Chan agreed that the issue could be discussed more broadly at the next ICG/PTWS regular meeting and recommended that SCSTAC and NWPTAC continue to discuss the matter also with PTWC as needed.

7. HARMONIZING FORMAT OF TSUNAMI BULLETINS ISSUED BY TSPs

Chair Sai-tick Chan recalled that this matter was raised by Singapore at the 8th session for the WG-SCS (4-6 March 2019,Jakarta, Indonesia), and presented a summary of the subject.

The Chair noted that further to WG-SCS-VIII, Ms. Patricia Ee of the Meteorological Service Singapore wrote to the Secretariat in December 2019 noting that "the tsunami bulletins issued by IOTWS, PTWC, NWPTAC and SCSTAC, including the RSTPs (India, Indonesia and Australia) are of different formats. Singapore noted that bulletins are used by NTWCs to assess the likely impact of tsunamis, and key information from the bulletins are also extracted and disseminated to our relevant agencies for their information."

Singapore indicated it would like to know if IOC would consider having a standard format for bulletins across the above-mentioned Centres. Noting that a standard format across Centres would help NTWCs to reduce the time required to extract the information. It would also make the process of extracting and disseminating the information seamless and more efficient. It might also reduce if not eliminate any delay in the dissemination process.

The Chair indicated that this being a global task in nature, he joined the agenda item on Harmonization of Format and Content of TSP Operational Products across ICGs & TSPs during the online Meeting of TOWS WG Inter-ICG Task Team on Tsunami Watch Operations (TT TWO) on 19 February 2020. The issue raised by Singapore was brought up to the attention of TT TWO meeting for discussion and follow-up. Mr Chan reported that the Chair of TT TWO acknowledged the issue but mentioned it would be a daunting global task, given the unique requirements of each AoS and all the training on use of products to users that had taken place over the years.

Chair Sai-tick Chan noted that the TT TWO meeting discussed about possible compilation of text bulletins in CAP (Common Alerting Protocol) format or XML format, similar to one developed by Australia. He also noted that NOAA had been using CAP to disseminate national tsunami advisory products, and ICG/IOTWMS was analysing the possibility of using CAP for handling national tsunami warnings in the Indian Ocean.

He reported that the ICG/IOTWMS was requested to provide an update on the progress of implementation at the next meeting of TT TWO. Dr McCreery confirmed that TT TWO would continue to discuss this subject at its next session.

Mr Nishimae (JMA) indicated that for Japan moving to standard bulletins (e.g. CAP) would require an important effort in terms of time and cost for all TSPs. Dr Yuan (NMEFC) mentioned they were discussing the matter with the China Meteorological Administration.

Chair Sai-tick Chan encouraged the TSPs to study the possibility of a pilot project to provide an additional channel of dissemination with a machine-readable format, for the benefit of the discussion of this issue with Member States.

8. HOSTING OF THE WG-SCS-IX SESSION

Chair Sai-tick Chan recalled that China was willing to host the Ninth meeting of the Regional Working Group on Tsunami Warning and Mitigation System for the South China Sea Region (ICG/PTWS-WG-SCS-IX) in Guangzhou, Guangdong province, China in March 2020.

He also recalled that Malaysia volunteered to host the 10th meeting of the Regional Working Group on Tsunami Warning and Mitigation System for the South China Sea Region in 2021.

He recalled further that the ICG/PTWS-WG-SCS-IX was subsequently cancelled owing to the outbreak of COVID-19. He reported that the Chair, China and the IOC Secretariat discussed the matter and intended to postpone ICG/PTWS-WG-SCS-IX to January 2021 tentatively, before ICG/PTWS-XXIX in Japan.

Chair Sai-tick Chan noted that it was highly uncertain whether it would be possible to hold ICG/PTWS-WG-SCS-IX in January 2021 as current pandemic continued to develop.

He also noted that in the larger context, the online meeting of ICG/PTWS Steering Committee in June 2020 discussed alternatives of hosting of ICG/PTWS XXIX, including:

1. meeting to take place as originally planned on 13-18 March 2021

2. in-person meeting with reduced number of participants combined with an online meeting

3. postponement of the meeting to later in 2021

He noted that with respect to PTWS XXIX further discussion would be made by the ICG/PTWS Steering Committee in September 2020.

With this context, he inquired Member States of the SCS-WG about the possibility of hosting the ICG/PTWS-WG-SCS-IX based on the available information?

Dr Yuan (NMEFC) indicated that there was no clear possibility of hosting the ICG/PTWS-WG-SCS-IX in January 2021, but China would apply for funding to host it during the fiscal year 2021-2022.

Malaysia confirmed that it continued to maintain its proposal to host ICG/PTWS-WG-SCS-X, after the 9th session to be hosted by China.

The Group had a brief discussion on the online meeting format and agreed that it was a good mechanism, both effective and useful.

The Group agreed that it should continue using the same mechanism until the pandemic was over, while valuing the in-person meetings for more in-depth discussion and decision making.

The **Group decided** to keep the possibility of an in-person meeting later in 2021 in Guangzhou, Guangdong province, China, with dates and venue to be discussed and determined in consultation with the Secretariat and the Chairperson. The Group welcomed the confirmation by Malaysia to host the 10th meeting.

9. ANY OTHER BUSINESS

Mr Ardito Kodijat, Head of IOTIC shared information about an IOTIC Online Series on IOC-UNESCO Tsunami Ready, available from the following website : http://www.ioc-tsunami.org/index.php?option=com_oe&task=viewEventRecord&eventID=2756, and also informed about a pre-IOWave20 Webinar on Standard Operating Procedures for Tsunami Early Warning and Emergency Response, available from this website: http://www.ioc-tsunami.org/index.php?option=com_oe&task=viewEventRecord&eventID=2673

Dr Yuan Ye recalled that NMEFC offered to host an Standard Operating procedures (SOP) training in 2021, which might not be possible due to funding restrictions related to the pandemic. He noted, however, that the programme of international scientist exchanges would continue. Dr Dakui Wang would provide more information on this matter soon through the Secretariat.

The Chair reminded the meeting that, according to the applicable procedures of IOC Subsidiary Bodies, duration of the working group was two years. Chair and at least one Vice-Chair would be elected by the ICG/PTWS or the members of the working group for two years with possible re-election for up to one more term in the same position. While the Chair Sai-tick Chan had been in the second term to serve as the Chair of SCS-WG, he invited the Member States to consider nomination of a new chair and vice-chair to the Secretariat before ICG/PTWS-XXIX.

10. CLOSE OF THE MEETING

The Chair Mr Sai-Tick Chan closed the meeting the 28 August at 9:30 am UTC.

ANNEX I

Online session of the ICG/PTWS Regional Working Group on Tsunami Warning and Mitigation System in the South China Sea Region (ICG/PTWS WG-SCS),

0700-0830 UTC, 27 & 28 August 2020

AGENDA

1. **WELCOME AND OPENING (10 minutes)**
2. **ORGANIZATION OF THE SESSION**
   - 2.1. ADOPTION OF AGENDA **(5 minutes)**
   - 2.2. CONDUCT OF THE SESSION, TIMETABLE AND DOCUMENTATION **(5 minutes)**
3. **REVIEW OF DECISIONS, RECOMMENDATIONS AND ACTIONS ARISING FROM ICG/PTWS WG-SCS-VIII MEETING (10 minutes)**
4. **REPORTS**
   - 4.1. BRIEF NATIONAL REPORTS TO SHARE MEMBER STATES' EXPERIENCE IN COPING WITH COVID-19 AND INDICATE SUPPORT THEY NEED FROM SCSTAC **(30 minutes)**
   - 4.2. REPORT FROM SCSTAC **(30 minutes)**
   - 4.3. REPORT FROM NWPTAC **(15 minutes)**
   - 4.4. STRUCTURE AND FUNCTIONS OF SELF-DEVELOPED TSUNAMI DECISION SUPPORTING SYSTEM AT SCSTAC **(15 minutes)**
5. **SEISMIC AND SEA LEVEL CORE STATIONS IN THE SOUTH CHINA SEA REGION FOR FURTHER ENHANCING TSUNAMI WARNING CAPABILITY (15 minutes)**
6. **ADVISORIES ISSUED BY TSPs FOR EARTHQUAKES THAT OCCUR OUTSIDE AOS BUT POSE A THREAT TO MEMBERS (10 minutes)**
7. **HARMONIZING FORMAT OF TSUNAMI BULLETINS ISSUED BY TSPs (10 minutes)**
8. **HOSTING OF THE WG-SCS-IX SESSION (15 minutes)**
9. **ANY OTHER BUSINESS (10 minutes)**
10. **CLOSE OF MEETING**

ANNEX II

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ANNEX III

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
WRS	Warning Receiver System