ESCAP/WMO
Typhoon Committee

MEMBER REPORT

SINGAPORE

ESCAP/WMO Typhoon Committee
17th Integrated Workshop
(Video conferencing)
29-30 November 2022

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UNITED NATIONS
Economic and Social
Commission for Asia and
the Pacific

World Meteorological
Organization

CONTENTS

I. Overview of tropical cyclones which have affected/impacted Member's area since the last Committee Session

1. Meteorological Assessment (highlighting forecasting issues/impacts)

Tropical Storms in the Indian Ocean, western Pacific Ocean or South China Sea may influence the weather patterns in Singapore and the surrounding region. Depending on the position and strength of the tropical storms, they may induce or enhance convective weather activities over Singapore and the surrounding areas. A weather system which is observed to be somewhat influenced by tropical cyclone activity is the Sumatra squall. Sumatra squalls are lines of thunderstorms which form over Sumatra or the Strait of Malacca and bring widespread thundery showers with occasional gusty winds to Singapore as they propagate eastward towards the South China Sea. On other occasions, the presence of tropical storms may also bring dry air masses from the Indian Ocean or the Java Sea and suppress the development of rain clouds, leading to fair and warm weather conditions over Singapore.

During the 2022 Pacific Typhoon season, there were a few occasions during which tropical storms resulted in the convergence of prevailing winds around the surrounding region of Singapore.

Typhoon Malakas, the first tropical storm of the season, developed over the Philippine Sea in early April and tracked generally northwards over the Pacific Ocean until 15 April 2022 when it became an extratropical cyclone. Possibly due to the influence of Typhoon Malakas, Singapore experienced consecutive spells of Sumatra squalls from 13 – 16 April 2022. Strong winds were recorded on all days and heavy rain fell on 15 and 16 April 2022.

In addition, there were also several Sumatra squalls likely associated with Typhoon Noru, which developed east of Philippine Sea around 21 September 2022. Typhoon Noru tracked westward and affected the Philippines between 25 – 26 September 2022 before making landfall on 28 September 2022, affecting Viet Nam, Laos, and Thailand between 28 – 30 September 2022. During this period, Singapore experienced a few spells of Sumatra squalls on 22, 25 and 29 September 2022. In particular, on 25 September 2022, the squall developed over Sumatra in the early hours and moved eastward, bringing heavy rain and gusty winds to Singapore in the early morning.

2. Hydrological Assessment (highlighting water-related issues/impact)

Nil.

3. Socio-Economic Assessment (highlighting socio-economic and DRR issues/impacts)

Nil.

4. Regional Cooperation (highlighting regional cooperation and related activities)

Nil.

II. Summary of Progress in Priorities supporting Key Result Areas

1. Enhancement of Weather Observation and Remote-Sensing Network

Main Text:

Meteorological Service Singapore (MSS) continues to enhance its weather observation and remote-sensing systems, including the back-end infrastructure. The on-going projects and planned initiatives are aimed to maintain and improve the capability, functionality, and sustainability of the observation and remote-sensing network to support MSS' operations and service delivery.

In 2022, MSS installed and commissioned a new X/L-band tracking antenna system with a 2.4 m satellite dish. Technology refreshes and upgrades have also been planned for the existing polar-orbiting satellite reception systems. MSS has plans to implement cloud-based computing to provide better usability, accessibility, and security to its systems processing data from the geostationary satellites, including the JMA's Himawari, CMA's Fengyun, and KMA's Geo-KOMPSAT satellites.

A technology refresh is in progress for the network of surface automatic weather stations located at over 100 sites across Singapore. A new wind profiler with phased-array antenna is being installed to replace the existing system. In June 2021, MSS operationalised a new Meisei upper air sounding system to replace the previous system.

Identified opportunities/challenges, if any, for further development or collaboration:

Nil.

Priority Areas Addressed:

Integrated

- Strengthen the cooperation between TRCG, WGM, WGH, and WGDRR to develop impact-based forecasts, decision-support, and risk-based warning.

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2. ASEAN Climate Outlook Forum (ASEANCOF) and Southeast Asia Regional Climate Centre Network (SEA RCC-Network)

Main Text:

2.1 ASEANCOF

Background

The ASEAN Climate Outlook Forum (ASEANCOF) was established in 2013, following the support at the 35th Meeting of the ASEAN Sub-Committee on Meteorology and Geophysics (ASCMG, July 2013). ASEANCOF provides collaboratively developed and consensus-based seasonal climate outlooks and related information on a regional scale, including risk assessment of heightened tropical cyclone activities and the associated atmospheric circulation anomalies. These activities support decision-making to manage climate-related risks and support sustainable development. The hosting of ASEANCOF sessions is rotated among ASEAN Member States and supported by the Meteorological Service Singapore (MSS), as host of the ASEAN Specialised Meteorological Centre (ASMC).

Recent Developments

Since 2020, ASEANCOF has been held virtually due to travel restrictions. ASEANCOF-17 was held online between 22 and 26 November 2021, over four half days. On the second day, there was an introductory training session on NextGen, a cross-timescales method to co-product and verify calibrated forecasts leveraging on the Climate Predictability Tool (CPT) developed by Columbia University's International Research Institute for Climate and Society. For the first time, the final day of ASEANCOF was open to all who were interested to attend. The theme was Disaster Risk Reduction (DRR), with four panellists invited to share and discuss their experience either producing or using climate information for DRR.

The most recent ASEANCOF-18 meeting was conducted online for the June-August (JJA) summer monsoon season of 2022, hosted by PAGASA. There was also a specific focus on monsoons, including the Asian-Australian Monsoons Working Group seeking feedback from the ASEAN NMHSs on plans to develop a regional monsoon index for Southeast Asia. The Consensus Outlook from ASEANCOF-18 for the region was published in late May 2022 (http://asmc.asean.org/events-eighteenth-session-of-the-asean-climate-outlook-forum-aseancof-18).

The next session, ASEANCOF-19, will be held at the end of November 2022, in a similar format to ASEANCOF-17, with the theme of climate services for the agriculture sector. While it was initially planned to continue with training for developing objective seasonal outlooks, this has been postponed until the next physical meeting.

Detailed meeting reports are available at http://asmc.asean.org/asmc_asean_conf_about.

2.2 SEA RCC-Network

Background

The Southeast Asia Regional Climate Centre Network (SEA RCC-Network) is an operational platform for delivery of climate services. The Network complements the ASEANCOF, which is primarily a platform for sharing best practices and improving the process of consensus-building for climate outlooks. An RCC-Network for the region was first proposed at the WMO RA V 16th Session (Jakarta, May 2014), and covers ten Southeast Asian countries in two WMO Regional Associations (RA), RA II and RA V. The SEA RCC-Network is currently in the demonstration phase.

As a group of centres (nodes), the SEA RCC-Network collectively fulfils the four mandatory functions of an RCC, namely long-range forecasting led by Singapore (MSS), climate monitoring led by the Philippines (PAGASA), operational data services led by Indonesia (BMKG), and training led by all three partners. Singapore is the current coordinator of the Network. Within the monitoring and long-range forecasting functions, assessments of tropical cyclone activities are included as deliverables by either the lead node or a contributing consortium member.

Recent Developments

Following the start of the demonstration phase for the SEA RCC-Network, the 3 nodes have since provided pilot products for long-range forecast, climate data services, and monitoring through their respective portals. These sites can be accessed from the recently updated main page of the SEA RCC-Network (https://www.mss-int.sg/sea-rcc-network). Since the demonstration phase, monthly climatologies for TC tracks and a two-week outlook are included on the website (https://www.mss-int.sg/sea-rcc-network/long-range-forecasting/tropical-cyclone/fortnightly-outlook) provided by PAGASA (the climatology will be expanded to cover all of Southeast Asia in the future). The SEA RCC-Network has also implemented a Climate Watch System. This Climate Watch initially focuses on the 1-month SPI, however, is expected to be expanded to other variables, including heightened risk of TC development, in the future.

Identified opportunities/challenges, if any, for further development or collaboration:

With the incorporation of objective seasonal outlooks in ASEANCOF, this provides the opportunity to improve the seasonal outlooks, including additional tailored products for the region. However, this shift requires all NMHSs in the region are involved in the process, which in turn requires training. Introductory sessions have been provided virtually, but as suitable in-depth online training is not available, the implementation of objective seasonal outlooks has been delayed (until 2023 or later).

Priority Areas Addressed:

Meteorology

- Develop and enhance typhoon analysis and forecast techniques from nowcast to medium-range, and seasonal to long-range prediction.

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3. Capability-Building Programme in Subseasonal-to-Seasonal Predictions for Southeast Asia (S2S-SEA) and Subseasonal-to-Seasonal Southeast Asia Pilot Project (S2S-SEA Pilot Project)

Main Text:

3.1 S2S-SEA

MSS, as host of the ASEAN Specialised Meteorological Centre (ASMC), conducts a Capability-Building Programme in Subseasonal-to-Seasonal Predictions for Southeast Asia (S2S-SEA). S2S-SEA is a multi-year series of workshops to equip the NMHSs with the knowledge and skills to deliver S2S predictions to end-users. The S2S predictions typically span timescales of 2 weeks to 2 months and has the potential to provide warnings for extreme rainfall events, caused by tropical storms or otherwise, but requires further studies.

The first two workshops, held in March 2017 and August 2018, focused on building the technical capability of the National Meteorological and Hydrological Services (NMHSs) in S2S predictions. For the third workshop in July 2019 (http://asmc.asean.org/publication-asmc-bulletin-issue-4-sep-2019), ASMC collaborated with ESCAP and RIMES to shift the focus to development of prediction products with involvement from end-user agencies and the disaster risk reduction community. The fourth workshop, also focused on engaging with end users, is expected to take place after the end of the S2S-SEA Pilot Project (2023).

3.2 S2S-SEA Pilot Project

S2S-SEA has embarked on a Pilot Project involving NMHSs, and national and regional users in the disaster risk reduction sector, with support from ESCAP and RIMES. Details on project can be found in the write up in the 3rd WMO Projects Newsletter (WMO Projects Newsletter 03 | World Meteorological Organization). The S2S-SEA Pilot Project is conducted under the S2S Real-Time Pilot initiative (S2S Real-Time Pilot Initiative (dtbs.RealtimePilot) - XWiki (s2sprediction.net)), the latter of which is scheduled to end November 2022.

As part of the S2S-SEA Pilot Project, ASMC has been providing fortnightly subseasonal outlooks to the AHA Centre (regional level partner) since February 2020. At the national level, there were challenges in implementing the project due to the COVID situation. At the national level, there were challenges in implementing the project due to the COVID situation. The Department of Meteorology and Hydrology, Myanmar (DMH) joined the project in July 2020, with several online meetings and discussions over case studies during 2020 and 2021. The pilot project will end in November 2022.

Identified opportunities/challenges, if any, for further development or collaboration:

Extreme rainfall anomalies from typhoon related activities typically predictable within one or two-week lead time based on preliminary assessment (PAGASA and others). Based on the case studies within this project, rainfall and atmospheric circulation anomalies have not shown much improvement of heightened chance of rainfall extremes arising from TCs, although there was at least one case where there was heightened chance of rainfall extremes associated with tropical cyclone activity three weeks ahead of time. However, additional calibration/statistical techniques may still help (not included as part of this pilot).

Products developed during this project, including the heightened chance of rainfall extremes, will continued to be developed, and are planned to make operational in 2023.

Priority Areas Addressed:

DRR

- Enhance Members' disaster risk reduction techniques and management strategies.

Meteorology

- Develop and enhance typhoon analysis and forecast techniques from nowcast to medium-range, and seasonal to long-range prediction.

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4. Collaborations with the National Water Agency to Manage and Maintain Adequate Water Supply

Main Text:

The National Water Agency of Singapore manages the water supply, water catchment, and used water in Singapore. Intense thunderstorms, prolonged heavy rain, and dry spell events can have an impact on the water levels in the water catchment areas. The National Water Agency requires accurate and reliable forecast across different time scales for water reservoir and flood management.

MSS provides a 7-Day daily rainfall forecast to the National Water Agency. The quantitative rainfall forecast product enables the National Water Agency to plan, prepare, and allocate necessary resources for flood management in the event of heavy rain events. In addition, MSS also provides a 3-month probabilistic rainfall outlook to the Agency for longer-term water resource management.

MSS works closely with the National Water Agency in several research and development projects, including the development of nowcasting system, installation of a new weather radar in Singapore, and the use of high-resolution weather models for heavy rain prediction.

Identified opportunities/challenges, if any, for further development or collaboration:

Nil.

Priority Areas Addressed:

Meteorology

- Enhance the capacity to monitor and forecast typhoon activities particularly in genesis, intensity, and structure change.

Hydrology

- Increase capacity in utilization of advanced science and technology for typhoon-related flood forecasting, early warning, and management.

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5. Hydrological Achievements and Results

Main Text:

Singapore has been improving the drainage infrastructure over the past decades. The flood-prone areas have been reduced from 3200 hectares in the 1970s to about 27.0 hectares today. Singapore continuously reviews and upgrades drainage infrastructure to ensure an effective drainage network for flood alleviation and prevention. Currently, there are more than 300 water level sensors around Singapore for monitoring of the drainage system. These water level sensors provide data on water levels in the drains and canals, enhancing the monitoring of real-time site conditions during heavy storms and response time.

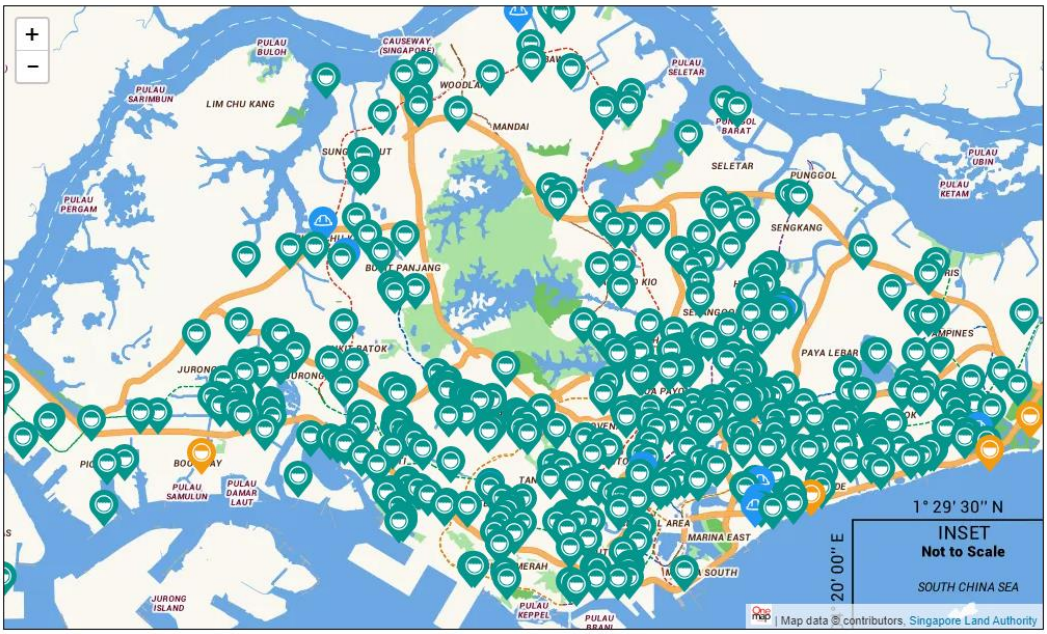

Figure 1: Water level stations installed in Singapore. (Source: Singapore Public Utilities Board)

Identified opportunities/challenges, if any, for further development or collaboration:

Nil.

Priority Areas Addressed:

<u>Hydrology</u>

- Enhance capacity in typhoon-related flood risk management (including land-use management, dam operation, etc.) and integrated water resources management and flood-water utilization.

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6. Participations in Training Workshops, Conferences and Meetings

Main Text:

Singapore participates in several meteorological training workshops, conferences, and meetings each year to ensure our meteorologists, research scientists, and staff are up-to-date with the latest scientific developments. Some of the relevant workshops, conferences and meetings attended in 2021/2022 are listed below:

Workshop/Conference/Meeting	Date	Location
• Webinar on 'A Strategic Pathway for the Indian Ocean Tsunami Warning and Mitigation System within the Context of UN Decade for Ocean Science'	Nov 2021	Online
• Seventh WMO International Workshop on Monsoons (IWM-7)	Nov 2021	Online
• Bureau of Meteorology (BOM)'s Annual R&D Workshop	Nov 2021	Online
• Technical meeting on a regional weather radar network for Southeast Asia	Nov 2021	Online
• Second Consultative Workshop on the ASEAN Framework for Anticipatory Action in Disaster Management	Jan 2022	Online
• Webinar on Seasonal and Sub-seasonal Weather Prediction	Mar 2022	Online

Identified opportunities/challenges, if any, for further development or collaboration:

The training workshops, conferences and meetings provided opportunities for officers to expand their knowledge and develop projects to better improve our services to users.

Priority Areas Addressed:

Integrated

- Enhance collaborative activities with other regional/international frameworks/organizations, including technical cooperation between TC/AP-TCRC and TC/PTC cooperation mechanism.

Meteorology

- Enhance training activities with TRCG, WGH, and WGDRR in accordance with Typhoon Committee forecast competency, knowledge sharing, and exchange of latest development and new techniques.

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Appendix I - Priority Areas of Working Groups for the Strategic Plan 2022-2026

WG	Priorities
Integrated	1. Strengthen the cooperation between TRCG, WGM, WGH, and WGDRR to develop impact-based forecasts, decision-support and risk-based warning.
	2. Strengthen cross-cutting activities among working groups in the Committee.
	3. Enhance collaborative activities with other regional/international frameworks/organizations, including technical cooperation between TC/AP-TCRC and TC/PTC cooperation mechanism.
Meteorology	4. Enhance the capacity to monitor and forecast typhoon activities particularly in genesis, intensity and structure change.
	5. Develop and enhance typhoon analysis and forecast techniques from nowcast to medium-range, and seasonal to long-range prediction.
	6. Enhance and provide typhoon forecast guidance based on NWP including ensembles, weather radar and satellite related products, such as QPE/QPF.
	7. Promote communication among typhoon operational forecast and research communities in Typhoon Committee region.
	8. Enhance training activities with TRCG, WGH, and WGDRR in accordance with Typhoon Committee forecast competency, knowledge sharing, and exchange of latest development and new techniques.
	9. Enhance RSMC capacity to provide regional guidance including storm surge, in response to Member's needs.
Hydrology	10. Improve typhoon-related flood (including riverine flood, flash flood, urban flood, and coastal flood) monitoring, data collection and archiving, quality control, transmission, processing, and sharing framework.
	11. Enhance capacity in typhoon-related flood risk management (including land-use management, dam operation, etc.) and integrated water resources management and flood-water utilization.
	12. Strengthen capacity in effective flood forecasting and impact-based early warning, including hazard mapping and anticipated risk based on methodological and hydrological modelling, and operation system development.
	13. Develop capacity in projecting the impacts of climate change, urbanization and other human activities on typhoon-related flood disaster vulnerability and water resource availability.
	14. Increase capacity in utilization of advanced science and technology for typhoon-related flood forecasting, early warning, and management.
DRR	15. Provide reliable statistics of mortality and direct disaster economic loss caused by typhoon-related disasters for monitoring the targets of the Typhoon Committee.
	16. Enhance Members' disaster risk reduction techniques and management strategies.
	17. Evaluate socio-economic benefits of disaster risk reduction for typhoon-related disasters.
	18. Promote international cooperation of DRR implementation project.
	19. Share experience/knowhow of DRR activities including legal and policy framework, community-based DRR activities, methodology to collect disaster-related information.