

**MEMBER
REPORT**
Singapore

**ESCAP/WMO Typhoon Committee
18th Integrated Workshop
ESCAP - UN Conference Center, Bangkok, Thailand
28 November – 1 December 2023**

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

1. Meteorological Assessment (highlighting forecasting issues/impacts)

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. One type of weather system which is observed to be 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 2023 Pacific Typhoon season, there were few occasions during which tropical storms resulted in the convergence of prevailing winds around the surrounding region of Singapore.

On 17 July 2023, Tropical Storm Talim made landfall over at Guangdong, China, before dissipating on 18 July as it moved further inland. Possibly due to the influence of Tropical Storm Talim making landfall, Singapore experienced two spells of widespread heavy thunderstorms on 18 July 2023.

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 implement, maintain, and enhance a comprehensive network of specialised meteorological observing systems and applications to support operational weather forecasting and the provision of meteorological services.

In 2023, MSS had successfully implemented a new phased-array wind profiler at the Changi Meteorological Station. MSS had also integrated an X-band TDWR radar with its existing S- and C-band doppler weather radars. On future plans, MSS will install a second X/L-band tracking antenna in 2024/2025 to improve service availability and to access newer NASA polar-orbiting satellites for smoke haze and weather monitoring. MSS has plans to implement cloud-based computing to process the data received from geostationary weather satellites, essentially the series of JMA's Himawari, KMA's Geo-KOMPSAT and CMA's Fengyun satellites. A technology refresh is also underway for MSS' network of surface automatic weather stations located at over one hundred sites across Singapore.

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

Nil.

Priority Areas Addressed:

Integrated

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

Key Pillars of UN's Early Warnings for All (EW4All) Initiative Addressed:

Key Pillars of EW4All	Please ✓ the related pillar(s)
Disaster risk knowledge and management	
Detection, observation, monitoring, analysis, and forecasting	✓
Warning dissemination and communication	
Preparedness and response capabilities	

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

Main text:

ASEANCOF

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, supported by the Meteorological Service Singapore (MSS) as host of the ASEAN Specialised Meteorological Centre (ASMC).

The most recent ASEANCOF-20 meeting was held in May 2023, conducted online for the June-August (JJA) summer monsoon season of 2023. The first day of the session covered an introduction to the downscaling and calibration tool ‘XCast’, as well as sharing of updates from NMHSs and others, while the second day covered the consensus discussion. There was also an open session to share the outlook and review with the wider community, along with a presentation on the impact of El Niño on Southeast Asia. The [ASEANCOF-20 Consensus Outlook](#) was published in late May 2023. Details of [previous sessions](#) are available at the ASMC website.

The next session, ASEANCOF-21, will be held at the end of November 2023, in a similar format to ASEANCOF-19. As ASEANCOF-21 marks ten years since the first ASEANCOF in December 2013, the theme of ASEANCOF-21 is ‘the future of climate services in Southeast Asia’.

SEA RCC-Network

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 entered the demonstration phase in November 2017.

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.

Following the start of the demonstration phase for the SEA RCC-Network, the three 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](#). Since the demonstration phase, monthly climatologies for TC tracks and a two-week outlook are included on the [website](#), provided by PAGASA. In 2023, the domain of the TC outlook was expanded to include more of the Bay of Bengal, to better support western Mainland Southeast Asia. The expansion of the TC track climatology to cover all Southeast Asia is still pending. 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 to be 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 (planned now for 2024).

Priority Areas Addressed:

Meteorology

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

Key Pillars of UN's Early Warnings for All (EW4All) Initiative Addressed:

Key Pillars of EW4All	Please ✓ the related pillar(s)
Disaster risk knowledge and management	
Detection, observation, monitoring, analysis, and forecasting	✓
Warning dissemination and communication	
Preparedness and response capabilities	

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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:

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 two weeks to two 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 last two workshops, held in July 2019 and August 2023, 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 S2S-SEA Pilot Project (2020 – 2022), under the S2S Real-Time Pilot initiative (s2sprediction.net/xwiki/bin/view/dtbs/RealtimePilot), aimed to assess the usefulness of S2S predictions for Disaster Risk Reduction, through the dissemination of real-time S2S predictions. 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 ended in November 2022. Between February 2020 and November 2022, ASMC provided fortnightly subseasonal outlooks (for up to three weeks) to the AHA Centre. While the pilot project ended in November 2022, ASMC has continued to provide a simplified version of the outlook, based on the feedback from the AHA Centre. Outcomes and lessons learnt from this project include a better understanding of predictive skill for the region, using multiple thresholds for heavy rainfall can be useful (particularly due to the differences in the climate across the region), as well as challenges in communicating between the different partner (particularly in a virtual setting).

The final S2S SEA V workshop was held in August 2023 over two virtual sessions and an in-person workshop on 22-24 August 2023, conducted in Singapore. The key elements of S2S-SEA IV included a focusing on the application of readily available S2S products, how to work with users to identify actions that can be taken, as well as a review of the fundamentals of S2S Prediction. The workshop finished with a discussion of next steps for collaboration in the region around improving S2S prediction and related services, including exploring a fortnightly online meeting for NMHSs in the region to discuss the current conditions and outlook.

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

Nil.

Priority Areas Addressed:

Meteorology

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

DRR

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

Key Pillars of UN's Early Warnings for All (EW4All) Initiative Addressed:

Key Pillars of EW4All	Please ✓ the related pillar(s)
Disaster risk knowledge and management	
Detection, observation, monitoring, analysis, and forecasting	✓
Warning dissemination and communication	
Preparedness and response capabilities	

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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.

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.

Key Pillars of UN's Early Warnings for All (EW4All) Initiative Addressed:

Key Pillars of EW4All	Please ✓ the related pillar(s)
Disaster risk knowledge and management	✓
Detection, observation, monitoring, analysis, and forecasting	✓
Warning dissemination and communication	
Preparedness and response capabilities	

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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.

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

Nil.

Priority Areas Addressed:

Hydrology

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

Key Pillars of UN's Early Warnings for All (EW4All) Initiative Addressed:

Key Pillars of EW4All	Please ✓ the related pillar(s)
Disaster risk knowledge and management	✓
Detection, observation, monitoring, analysis, and forecasting	
Warning dissemination and communication	
Preparedness and response capabilities	

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6. Participations in Training Workshops, Conferences and Meetings

Main text:

Singapore participates in regional and international meteorological training workshops, conferences, and meetings each year to ensure MSS' meteorologists, research scientists, and staff are up to date with the latest scientific developments. Some of the relevant participations in 2023 are listed below:

Workshop/Conference/Meeting	Date	Location
• Weather Radar Workshop	Oct 2023	Japan
• Fifth session of the WMO Steering Group for the Space-based Weather and Climate Extremes Monitoring in East Asia and Western Pacific (SG-SWCEM-EAWP-5)	Jul 2023	Virtual
• 3 rd Meeting of the G20 Disaster Risk Reduction (DRR) Working Group	Jul 2023	India
• WMO Subseasonal to Seasonal (S2S) Guidance Document Writing Workshop	May 2023	Switzerland
• Weather and Climate Science for Service Partnership Southeast Asia (WCSSP SE Asia) 5th Regional Science Workshop	May 2023	Viet Nam

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.

Key Pillars of UN's Early Warnings for All (EW4All) Initiative Addressed:

Key Pillars of EW4All	Please ✓ the related pillar(s)
Disaster risk knowledge and management	
Detection, observation, monitoring, analysis, and forecasting	✓
Warning dissemination and communication	
Preparedness and response capabilities	✓

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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 WGD RR 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 WGD RR 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.