

**SUMMARY OF MEMBERS' REPORTS
2022**

(submitted by AWG Chair)

Summary and Purpose of Document:

This document presents an overall view of the progress and issues in meteorology, hydrology and DRR aspects among Typhoon Committee (TC) Members with respect to tropical cyclones and related hazards in 2022

Action Proposed

The Committee is invited to:

- (a) take note of the major progress and issues in meteorology, hydrology and DRR activities in support of the 19 Priorities detailed in the Typhoon Committee Strategic Plan 2022-2026; and
- (b) Review the Summary of Members' Reports 2022 in APPENDIX B with the aim of adopting it as an "Executive Summary" for distribution to Members' governments and other collaborating or potential sponsoring agencies for information and reference.

APPENDICES:

- 1) Appendix A – DRAFT TEXT FOR INCLUSION IN THE SESSION REPORT
- 2) Appendix B – SUMMARY OF MEMBERS' REPORTS 2022

**APPENDIX A:
DRAFT TEXT FOR INCLUSION IN THE SESSION REPORT**

6.2 SUMMARY OF MEMBERS' REPORTS

1. *The Committee took note of the Summary of Members' Reports 2022 highlighting the key tropical cyclone impacts on Members in 2022 and the major activities undertaken by Members under the TC Priorities and components during the year.*
2. *The Committee expressed its sincere appreciation to AWG Chair for preparing the Summary of Members' Reports and the observations made with respect to the progress of Members' activities in support of the 19 Priorities identified in the TC Strategic Plan 2022-2026.*

Recommendations of AWG

3. *Consider the key tropical cyclone impacts on Members in 2022 and review the initiatives and activities to be pursued in support of the 19 TC Priorities to mitigate future impacts.*
4. *Adopt Section 2 of the Summary of Members' Reports 2022 as an "Executive Summary" to be distributed to Members' governments for information and reference.*
5. *Any other text to be included in the Session Report.*

**APPENDIX B:
SUMMARY OF MEMBERS' REPORTS 2022**

T C Lee (AWG Chair)

This document concisely summarizes the key tropical cyclone activity/impacts in the Typhoon Committee region in 2022 and Members' major initiatives supporting the Typhoon Committee Priorities based on Members' Reports submitted for the 17th Integrated Workshop (17th IWS) hosted by TCS and conducted by video conference on 29-30 November 2022. For detailed information and interpretation, please refer to the corresponding Member Report in the Member Report Section of the 17th IWS website:

(<https://www.typhooncommittee.org/17IWS/Members17IWS.html>)

1. Objectives

The objectives of this Summary are to extract the key aspects of tropical cyclone impact and related topical issues of regional interest in Members' countries or territories, and to consolidate the information and observations for:

- (a) the attention of Members' governments to encourage allocating the necessary resources for the purposes of operational effectiveness and readiness, disaster mitigation and risk reduction, or leveraging available resources and support for technology transfer and capacity-building through regional cooperation initiatives; and
- (b) reference by sponsoring agencies with a view to coordinating and synergizing effort in the planning of relevant projects and programmes for such purposes, as well as channeling resources and aids into identified areas of gaps or needs.

2. Key Observations in 2022

2.1 Overview (courtesy of RSMC Tokyo – Typhoon Center)

In 2022, there were 25 named tropical cyclones formed in the western North Pacific and the South China Sea, almost the same as the 30-year average of 25.1 during 1991 – 2020. Ten out of them reached typhoon intensity, which was below the 30-year average of 13.3. 12 named tropical cyclones formed during the peak formation period from August to September, which was above the normal of 10.7.

The mean genesis point of named tropical cyclones in 2022 was 19.3°N and 135.8°E, which showed a northward deviation from that of the 30-year average (16.3°N and 135.9°E). The northward shift of the mean genesis point throughout the year is partly due to the La Niña event which persisted in 2022 and due also to the intrusion of high potential vorticity from the higher latitude over the central Pacific to the sea south of

Japan. The mean duration of tropical cyclones sustaining tropical storm intensity or higher in the year was 3.7 days, shorter than that of the 30-year average (5.2 days).

The 2022 tropical cyclone season started with Malakas (2201) which formed over the sea around the Chuuk Islands on 6 April 2022. It is also the first tropical cyclone reaching typhoon intensity in the western North Pacific in the year. The last-named tropical cyclone in the year was Pakhar (2225). It formed in December 2022 over the sea east of the Philippines and eventually transitioned into an extratropical cyclone over the seas south of Japan.

2.2 The Challenges of COVID-19 Pandemic

Since the outbreak of COVID-19 in early 2020, the impacts of the COVID-19 pandemic have been deep and wide, especially on international travel and meetings. With no exception, the activities of the Typhoon Committee in 2022/23 were still affected by the pandemic with some of the face-to-face events being converted to online or hybrid mode. Amid the COVID-19 pandemic, it is encouraging to see that Typhoon Committee Members continued to deliver professional services to protect the community from the impacts of tropical cyclones and extreme weather events. In 2022, Members continued to utilize the virtual platform effectively to carry out working group meetings, operational coordination, research collaboration, and training activities. With the coordination of the Typhoon Committee Secretariat (TCS), the 54th Session of the Committee and the 17th Integrated Workshop (17th IWS) kindly hosted by Lao PDR and TCS respectively, were successfully conducted by means of video conferencing in 2022. Moreover, the 11th WGH Working Meeting held in Japan and the 5th WGM Working Meeting held in Malaysia were conducted in hybrid mode in October 2022. Training and research programmes of the Typhoon Committee were also carried out using online or hybrid approaches with satisfactory results, including the forecaster training courses offered by the China Meteorological Administration (CMA) and Japan Meteorological Agency (JMA), the Workshop on Typhoon Forecasting Techniques hosted by the Malaysian Meteorological Department (MET Malaysia) as well as the research fellowship offered by the Hong Kong Observatory (HKO).

2.3 Members' initiatives supporting the Priorities of the Typhoon Committee Strategic Plan (2022-2026)

The table below consolidates Members' key initiatives as reported in their respective Member reports submitted for the 17th IWS. The numbers of initiatives are an indication of which Priorities received relatively more emphasis from the initiatives reported by the Members.

WG	No.	Priorities	No. of initiatives
Integrated	1	Strengthen the cooperation between TRCG, WGM, WGH, and WGDRR to develop impact-based forecasts, decision-support and risk-based warning.	20
	2	Strengthen cross-cutting activities among working groups in the Committee.	3
	3	Enhance collaborative activities with other regional/international frameworks/organizations, including technical cooperation between TC/AP-TCRC and TC/PTC cooperation mechanism.	18
Meteorology	4	Enhance the capacity to monitor and forecast typhoon activities particularly in genesis, intensity and structure change.	24
	5	Develop and enhance typhoon analysis and forecast techniques from nowcast to medium-range, and seasonal to long-range prediction.	19
	6	Enhance and provide typhoon forecast guidance based on NWP including ensembles, weather radar and satellite related products, such as QPE/QPF.	15
	7	Promote communication among typhoon operational forecast and research communities in Typhoon Committee region.	6
	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.	8
	9	Enhance RSMC capacity to provide regional guidance including storm surge, in response to Member's needs.	2
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.	6
	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.	3
	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.	19
	13	Develop capacity in projecting the impacts of climate change, urbanization and other human activities on typhoon-related flood	1

		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.	6
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.	1
	16	Enhance Members' disaster risk reduction techniques and management strategies.	24
	17	Evaluate socio-economic benefits of disaster risk reduction for typhoon-related disasters.	2
	18	Promote international cooperation of DRR implementation project.	4
	19	Share experience/knowhow of DRR activities including legal and policy framework, community-based DRR activities, methodology to collect disaster-related information.	8

3. Summary of Members' Reports

3.1 Cambodia

No member report was submitted by Cambodia for 2022.

3.2 China

From 1 January to 31 October 2022, seven tropical cyclones affected China and four of them (Chaba, Mulan, Ma-on and Muifa) made landfall in the coastal area of China. The heavy rain associated Chaba affected 17 provinces, including Hainan, Guangxi, and Guangdong. A record-breaking daily rainfall of 421.6 mm was recorded at Sanya, Hainan. Muifa made landfall for four times respectively in Zhejiang, Shanghai, Shandong, and Liaoning Provinces, bringing high winds and heavy rain to these regions. Over 600 mm of rainfall was recorded in Shangyu, Shengzhou in Shaoxing and Yuyao in Ningbo. The daily rainfall of Fushan in Shandong also exceeded the historical extreme value of that station. In total, about 4.7 million people were affected by these seven tropical cyclones and there were three deaths/missing during the passage of Chaba.

China reported on 8 major initiatives supporting the Typhoon Committee Priorities, including the discriminating technique of typhoon rapid intensification based on AI, advances in numerical modeling of tropical cyclones, space-air-ground collaborative target observation and assimilation for typhoon forecast in the South China Sea, tropical cyclone observation experiment, establishment of operational platform and data application of Fengyun Series Satellites, improvement of typhoon-related disaster management, advances in tropical cyclone scientific research and tropical cyclone operational skill training of CMA.

3.3 Democratic People's Republic of Korea (DPRK).

Five tropical cyclones (Songda, Trases, Hinnamnor, Muifa and Nanmadol) affected DPRK in 2022. DPRK was impacted by the heavy rain brought by Songda, Trases, Hinnamnor and Muifa and the gales associated with Muifa and Nanmadol. In particular, during the passage of Songda, over 300 mm of rainfall was recorded in the middle, southern and eastern parts of the country. There was no major damage reported due to these tropical cyclones.

DPRK reported on 5 major initiatives in support of the Typhoon Committee Priorities, including the improvement of typhoon forecasting and related information dissemination services, update of the Typhoon Operational Prediction System (TOPS), effort for reducing typhoon-related disasters and strengthening regional cooperation.

3.4 Hong Kong, China

Six tropical cyclones affected Hong Kong, China in 2022. Three of them, namely Chaba, Ma-on and Nalgae, necessitated the issuance of the No.8 Gale or Storm Wind Signals in Hong Kong. In particular, Nalgae moved very close to Hong Kong in early November 2022, necessitating the issuance of Gale or Storm Wind Signal in November again since

1972. At least three persons were injured in Hong Kong during the passage of Chaba. Under the high winds brought by Nesat, seven passengers were injured when a double-decker bus was hit by a fallen tree. One person was injured during the passage of Ma-on. In terms of heavy rain associated with tropical cyclones, tropical depression and Mulan in August 2022 brought more than 100 millimetres of rainfall over Hong Kong.

Hong Kong, China reported on 14 major initiatives in support of the Typhoon Committee Priorities. Notable achievements include the continued effort in conducting tropical cyclone surveillance flights in the Hong Kong Flight Information Region and deploying drifting buoys over the South China Sea and the western North Pacific, the enhancement in monitoring and forecasting of multi-hazard combined effect related to tropical cyclones, the development of the Hydrometric Information System, the trial of image-based flooding analytics, new initiatives and tools for tropical cyclone monitoring and forecasting, and the on-going activities in enhancing public understanding of tropical cyclone and various related hazards.

3.5 Japan

In 2022, 11 tropical cyclones (Malakas, Aere, Songda, Trases, Meari, Hinnamnor, Muifa, Nanmadol, Talas, Kulap and Roke) of tropical storm intensity or higher came within 300 km of the Japanese archipelago as of 4 November 2022. Nanmadol and Talas brought heavy rain to the Kyushu and Chubu regions, causing river overflow, inland flooding and sediment disasters. These two tropical cyclones resulted in 8 fatalities, 19 serious and 140 minor injuries. 15 houses were destroyed, 24 seriously damaged and 971 partially damaged. There were also 4,877 instances of flooding above floor level, and 4,925 instances of flooding below floor level.

Japan reported on 11 major initiatives in support of Typhoon Committee Priorities, including the operational satellite switchover from Himawari-8 to Himawari-9, the upgrades of tropical cyclone heat potential products on the Numerical Typhoon Prediction (NTP) website, upgrade of JMA's global ensemble prediction system and Storm Surge Watch Scheme (SSWS) model, provision of information on the probability of warnings for storm surges and evaluated a preliminary seasonal TC forecast product for WNP region. Moreover, Japan continued to organize TC attachment training and 11th TC WGH meeting virtually, and hosted the 4th Asia-Pacific Water Summit, Asian Conference on Disaster Reduction and ADRC visiting researcher program.

3.6 Lao PDR

From 1 January to 25 November 2022, four tropical cyclones (Mulan, Ma-On, Noru, and Sonca) affected Lao PDR. During their passages, the water levels in some areas along the Mekong River and its tributaries reached danger level. Mulan caused heavy rain followed by flooding in 9 provinces, including Savannakhet Province, Luang Prabang Province and Vientiane capital. More than 40,000 people were affected and 540 houses were partially damaged. Damages to agriculture and infrastructure, and loss of livestock were also reported. During the passage of Ma-On, two fatalities were reported and thousands of people were affected by flash flooding.

3.7 Macao, China

Six tropical cyclones affected Macao, China in 2022. Four of them, namely Chaba, Mulan, Ma-On and Nalgae, resulted the issuance of the No. 8 Tropical Cyclone Warning Signal. In particular, wind speed up to force 10 with a maximum gust of 124 km/hr was recorded during the passage of Chaba. Heavy showers associated with Chaba also brought over 100 mm rainfall to Macao. Flooding of about 0.50 m high occurred in low-lying areas and the Yellow Storm Surge Warning was issued. Two injuries were reported and 32 incidents were reported, including flooding, fallen trees, scaffoldings and billboards collapsed or tottered.

Macao reported on 7 major initiatives in support of Typhoon Committee Priorities, including the enhancement in public weather service on alert messages, the engagement in personnel capacity-building activities and the establishment of the Tropical Cyclone Interdepartmental Video Meeting mechanism. Facing the impacts brought by tropical cyclones, storm surges and rainstorms, SMG introduced a precipitation nowcasting system and enhanced their storm surge forecast model. Macao continued to organize activities to promote the knowledge of meteorology and disaster risk reduction, to educate the public on disaster prevention, and to hold the annual emergency exercise for storm surge.

3.8 Malaysia

For the period between 1 November 2021 and 31 October 2022, six tropical cyclones, namely Nyatoh, Rai, Malakas, Megi, Noru and Kulap affected Malaysia. During 17-19 December 2021, Rai hit East Peninsular Malaysia, passed the Titiwangsa Range and coincided with a low pressure system at Klang Valley, leading to very heavy rainfall and extreme flooding at many places. The highest 24-hour rainfall recorded at Ladang Pulau Carey was 356 mm, which equates to a return period of over 100 years. 13 stations in Selangor and 2 stations in Kuala Lumpur also showed rainfall return period of more than 100 years.

Malaysia reported on 3 major initiatives in support of Typhoon Committee Priorities. Malaysia continued to work on the annual operating plan 6 (AOP6) for Working Group of Hydrology, including the 3L Water Level Gauge (WLG) installation. MET Malaysia enhanced its radar observation network with addition of 3 new radars. MET Malaysia also developed the Radar Integrated Nowcasting System (RaINS) and evaluated its accuracy during two tropical cyclone events in Malaysia.

3.9 The Philippines

From 1 January 2022 to 3 November 2022, 17 tropical cyclones were observed within the Philippine Area of Responsibility, five of them (Megi, Ma-On, Noru, Nesat and Nalgae) made landfall over the Philippine archipelago. These five tropical cyclones resulted in 384 fatalities, 171 missing individuals and 211 injuries. In particular, Megi brought torrential rain which resulted in massive flooding and landslides in Eastern Visayas. A total accumulated rainfall of 996.8 mm was recorded at the station in Baybay, Leyte.

In support of Typhoon Committee Priorities, PAGASA reported on 2 major initiatives on

the update of the Tropical Cyclone Warning System and conducting Information, Education and Communication (IEC) Activities.

3.10 Republic of Korea (ROK).

From 1 January 2022 to 15 November 2022, five tropical cyclones (Aere, Songda, Trases, Hinnamnor and Nanmadol) affected the Korean Peninsula. In particular, Hinnamnor made landfall in Geoje and moved to Busan and Gyungbuk, causing localized heavy rainfall and river flooding in some areas. During the passage of Hinnamnor, accumulated precipitation of more than 931 mm was recorded at Mt. Halla on Jeju Island and more than 370 mm at Pohang in the southeast of the Korean Peninsula. 15 fatalities were reported. It also caused damages to more than 5,000 houses and 10,000 small business, and loss of more than 300 ha of farmland.

ROK reported on 12 major initiatives in support of Typhoon Committee Priorities, including the development of a new statistical model for seasonal prediction of WNP typhoon activities, deployment of drifting buoys for typhoon forecasts and analysis, organizing training on capacity building for typhoon monitoring and forecasting platform, and the research project on construction of hydrological data quality control system in TC members. Moreover, ROK established a comprehensive national strategy for urban and river flooding and a service blueprint for national flood forecasting with artificial intelligence. ROK also attended the Capacity Building and Knowledge Sharing in DRR program, set up a Flood Alert System and Automatic Rainfall Warning System (ARWS) with PAGASA, and virtually held the 17th Annual Meeting of Typhoon Committee Working Group on DDR.

3.11 Singapore

In 2022, there were a few occasions during which tropical cyclones resulted in the convergence of prevailing winds around the surrounding region of Singapore. Possibly due to the influence of Malakas and Noru, spells of Sumatra squalls brought heavy rain and gusty winds to Singapore from 13-16 April 2022 and 22-29 September 2022 respectively.

Singapore reported on 6 major initiatives supporting Typhoon Committee Priorities, including the recent developments of ASEAN Climate Outlook Forum (ASEANCOF) and Southeast Asia Regional Climate Centre Network (SEA RCC-Network), and the progress of 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). MSS continued to enhance its weather observation and remote-sensing systems, and collaborated with the National Water Agency in research and development projects to manage water supply. Singapore also continued to improve their drainage infrastructure and participate in training workshops, conferences and meetings.

3.12 Thailand

From 1 November 2021 to 31 October 2022, Thailand was directly impacted by Noru which made landfall in Vietnam before moving further into Lao PDR and entering Thailand. Moreover, five tropical cyclones (Chaba, Mulan, Ma-On, Sonca and Nesat) took

some effects on the rainfall of Thailand. Noru brought plentiful rainfall in majority areas of upper Thailand. Over 200 mm of rainfall was recorded at Mueang Chan, Si Sa Ket on 28 September 2022. The heavy rain induced flooding and landslides in several areas during its passage, affecting more than 240,000 households in 54 provinces.

Thailand reported on 5 major initiatives supporting Typhoon Committee Priorities, relating to the activities of the IMO Member State Audit Scheme, Office of the National Water Resources, and Department of Disaster Prevention and Mitigation.

3.13 United States of America

In the central North Pacific, the tropical cyclone season featured below normal activity across the Area of Responsibility (AOR) of RSMC Honolulu with one tropical cyclone, Darby, entering the central North Pacific during the period from 1 January through 15 November 2022. There was near to below normal rainfall in the year. For the western North Pacific, due to the La Nina influence, the tropical cyclone activity in the region continued to be below-normal within the Guam AOR. Since 1 November 2021, only two tropical cyclones had significant impacts in the Guam AOR, namely Malakas and Banyan. During the passage of Banyan, the torrential rain and high winds brought wide-spread wind damage, flooding and several mudslides to the Republic of Palau.

The USA reported on 9 major initiatives supporting Typhoon Committee Priorities, including Weather-Ready Nation Ambassador Program, Annual Tropical Cyclone Exercises, Pacific International Training Desk, “StormReady” and “TsunamiReady” programs, various technological improvements and other outreach and education activities on hydrological and DRR.

3.14 Viet Nam

Up to November 2022, there were seven tropical storms and two tropical depressions in Bien Dong Sea of which three tropical storms and one tropical depression made landfall in the mainland of Vietnam. Noru was the strongest typhoon affecting Vietnam in 2022. The extreme heavy rain associated with Noru brought 300-500 mm rainfall to Nghe An and over 600 mm rainfall was also registered at Quynh Luu and Con Cuong, causing serious flooding in low-lying areas and along the river areas in the region. Moreover, there were 24 heavy rain events, 197 thunderstorms causing more than 200 inundation, flash floods, landslides events in Viet Nam in 2022. Till November 2022, natural disasters in Viet Nam caused 133 dead/missing and 154 people injured; 656 houses completely collapsed and 12,441 houses damaged; more than 500,000 cattles and poultry died; and 121,642 km of roads were damaged.

Viet Nam reported on 3 major initiatives supporting Typhoon Committee Priorities, including Central Data Hub, Impact-based Forecast and Warning Services, and Short-range Regional Ensemble Prediction System.