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SUMMARY OF MEMBERS' REPORTS 2021

(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 TC Members with respect to tropical cyclones and related hazards in 2021

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 21 Priorities detailed in the Typhoon Committee Strategic Plan 2017-2021; and
- (b) Review the Summary of Members' Reports 2021 in APPENDIX B with the aim of adopting 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 2021

**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 2021 highlighting the key tropical cyclone impacts on Members in 2021 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 21 Priorities identified in the TC Strategic Plan 2017-2021.*

Recommendations of AWG

3. *Consider the key tropical cyclone impacts on Members in 2021 and review the initiatives and activities to be pursued in support of the 21 TC Priorities to mitigate future impacts.*
4. *Adopt Section 2 of the Summary of Members' Reports 2021 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 2021**

T C Lee (AWG Chair)

This document concisely summarizes the key tropical cyclone activity/impacts in the Typhoon Committee region in 2021 and Members' major initiatives supporting the Typhoon Committee Priorities based on Members' Reports submitted for the 16th IWS hosted by UNESCAP and conducted by video conference on 2-3 December 2021. For detailed information and interpretation, please refer to the corresponding Member Report in the Member Report Section of the 16th IWS website: (<http://www.typhooncommittee.org/16IWS/Members16IWS.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 2021

2.1 Overview (courtesy of RSMC Tokyo – Typhoon Center)

In 2021, there were 22 named tropical cyclones (TCs) formed in the western North Pacific and the South China Sea, which was below the 30-year average (25.1, average for 1991 – 2020). Nine out of them reached typhoon intensity or higher, which was below the 30-year average of 13.3. Eight named TCs formed from August to September (the peak formation period), which was also less than the 30-year average of 10.7, mainly due to inactive convection over the sea area where TCs frequently form. The below normal annual total TC number in 2021 may be attributed to the lower number of TC formation during the peak period.

The mean genesis point of named TCs was 16.0°N and 132.4°E which showed a west-southwestward deviation from that of the 30-year average (16.3°N and 135.9°E). The

mean duration of TCs sustaining tropical storm intensity or higher was 5.5 days, slightly longer than that of the 30-year average (5.2 days).

Djuan (2101) – the first named TC of 2021 – formed in February as a tropical depression over the sea around the Caroline Islands. The last named TC, Rai (2122) formed in December over the sea around the Caroline Islands. Rai swept across the Philippines with super typhoon intensity and brought intense wind and heavy rain to the region.

2.2 Facing 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 with the spreading of the Delta and Omicron variants in 2021. The crisis significantly affected different sectors and activities around the world amidst the unprecedented global travel restrictions and border closure as well as strict social distancing measures in many countries/places. With no exception, the activities of the Typhoon Committee in 2021/22 were also beset by the pandemic with some of the planned events either cancelled or postponed. While the pandemic posed a great challenge to the implementation of the Typhoon Committee activities, it is encouraging to see that Typhoon Committee Members strived to deliver professional services to protect the community from the impacts of tropical cyclones and extreme weather events. Moreover, Members utilized the virtual platform to carry out working group meetings, operational coordination, research collaboration, and training activities effectively. In particular, with the coordination of the Typhoon Committee Secretariat, the 53rd Session of the Committee and the 16th Integrated Workshop kindly hosted by Japan and ESCAP respectively, were successfully conducted by means of video conferencing in 2021. Some of the training and research programmes of the Typhoon Committee were also carried out using online approach with satisfactory results, such as the forecaster training courses offered by CMA and JMA as well as the research fellowship offered by HKO.

2.3 Members' initiatives supporting the Priorities of the Typhoon Committee Strategic Plan (2017-2021).

The table below consolidates Members' key initiatives as reported in their respective Member reports submitted for the 16th 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	Enhance activities to develop impact-based forecast and risk-based warning.	31
	2	Strengthen cross-cutting activities among working groups in the Committee.	6
	3	Enhance collaborative activities with other regional/international frameworks/organizations, including TC and PTC cooperation mechanism.	16
Meteorology	4	Enhance the capacity to monitor and forecast typhoon activities particularly in genesis, intensity and structure change.	39
	5	Develop and enhance typhoon analysis and forecast technique from short- to long-term.	22
	6	Enhance and provide typhoon forecast guidance based on NWP including ensembles and weather radar related products, such as QPE/QPF.	15
	7	Promote communication among typhoon operational forecast and research communities in Typhoon Committee region.	11
	8	Strengthen the cooperation with WGH and WGDRR to develop impact-based forecast and risk-based warning.	4
	9	Enhance, in cooperation with TRCG, training activities in accordance with Typhoon Committee forecast competency, knowledge sharing, and exchange of latest development and new techniques.	3
	10	Enhance RSMC capacity to provide regional guidance including storm surge, responding to Member's needs.	1
Hydrology	11	Improve typhoon-related flood (including river flood, urban flood, mountainous flood, flash flood and storm surge, etc the same below) monitoring data collection, quality control, transmission, and processing.	5
	12	Enhance capacity in typhoon-related flood risk management (including dam operation), integrated water resources management and flood-water utilization.	3
	13	Enhance capacity in impact-based and community-based operational flood forecasting and early warning, including methodology research, hydrological modeling, and operation system development.	8
	14	Enhance capacity in flood risk (hazard, inundation) information, mapping, and its application.	2
	15	Enhance capacity in assessment and dealing with the impacts of climate change, urbanization, and other human activities on typhoon-related flood disaster vulnerability and water resources availability.	9
	16	Enhance capacity in advanced technology (including satellite data, GIS, RS, QPE/QPF, ensemble, parallel computing) utilization in typhoon-related flood forecasting and early warning, and hydrological modeling.	3

DRR	17	Provide reliable statistics of mortality and direct disaster economic loss caused by typhoon-related disasters for monitoring the targets of the Typhoon Committee.	2
	18	Enhance Members' disaster reduction techniques and management strategies.	13
	19	Evaluate socio-economic benefits of disaster risk reduction for typhoon-related disasters.	2
	20	Promote international cooperation of DRR implementation project.	9
	21	Share experience/know-how of DRR activities including legal and policy framework, community-based DRR activities, methodology to collect disaster-related information.	12

3. Summary of Members' Reports

3.1 Cambodia

While no tropical cyclone affected Cambodia from January through October 2021, Cambodia was affected by thunderstorm and flooding triggered by monsoon trough this year. The accumulated rainfall was higher than normal in April, May, August, September and October. There were heavy rainfall and flooding on 16 – 19 April, 14 July, 24 August, 31 August and 20 October. One man was killed after being swept away by the flood waters on 24 August. As drainage channels overflowed, there were 1 metre of flood water around some areas in Sihanoukville and Koh Kong province. 2021 was also hotter than normal with the highest temperature in April of 41.5°C.

Cambodia reported on FOUR major initiatives supporting Typhoon Committee Priorities. Cambodia attended online meeting to discuss with WMO GTS/MSS expert regarding the establishment of GTS/WIS connection. Cambodia also worked online with ORI, RTH Bangkok and JMA on GTS/MSS installation and upgrading Himawari-cast software. Cambodia worked with KMA on the installation of the Automated Weather Observation System for Forecasting and Warning of Natural Disaster, and attended training course on capacity building for the installation of the system.

3.2 China

Up to 15 November 2021, a lower-than-average five tropical cyclones (In-fa, Cempaka, Lupit, Lionrock and Kompasu) made landfall over coastal China. In-fa made landfall over the coastal area of Zhejiang Province on 25 July, affecting 7 provinces and 4 cities, bringing 100 – 250 mm of rainfall, and rainfall evening exceeding 700 mm in the northern part of Zhejiang province. Cempaka and Lupit affected the coastal area of southern China and brought strong winds and heavy rainfall. Lionrock and Kompasu hit Hainan and southern China in quick succession within a week in October 2021, bringing heavy rain and strong winds over the region.

China reported on EIGHT major initiatives supporting Typhoon Committee Priorities, including application of Machine Learning in the technique of Typhoon Vortex Detection, establishment of Center for Earth System Modeling and Prediction of CMA, Tropical Cyclone field experiment of In-fa and Lionrock, enhancement of forecast reviews over significant tropical cyclone events, and advances in TC Scientific research including genesis forecast of tropical depression over the South China Sea. CMA also enhanced their Typhoon-related Disaster Management by conducting the first national comprehensive survey on Natural Disaster Risks and development of an empirical estimation model for tropical cyclone precipitation. Moreover, CMA conducted training workshop on Tropical Cyclone Operational Skill Training

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

DPRK was impacted by a total of four tropical cyclones (In-fa, Lupit, Omais and Chanthu) in 2021. These typhoons caused gales, heavy rain, torrential rain and storm surge, but there was no damage in several sectors.

In support of Typhoon Committee Priorities, DPRK introduced super ensemble sub-setting technique in typhoon track forecasting in order to improve accuracy. DPRK also developed a new version of Typhoon Operational Prediction System (TOPS) into operational use. The State Hydro-Meteorological Administration also made improvements in the delivery of typhoon related information to the public by working closely with the national government to ensure the safety of people and minimize damage to property and infrastructure. DPRK noted with thanks the numerical weather prediction suite of products from ECMWF, CMA, JMA, and NCEP for their role in assisting their forecasters in making accurate and timely warnings for typhoon related impacts in 2021.

3.4 Hong Kong, China

Eight tropical cyclones (Koguma, two tropical depressions, Cempaka, Lupit, Lionrock, Kompasu and Rai) affected Hong Kong, China in 2021. Lionrock and Kompasu successively affected Hong Kong within a week from 8 to 14 October 2021 and the No. 8 Gale or Storm Signals were issued for both tropical cyclones with only a break time of 60 hours and 40 minutes in between the two No.8 signals, the shortest record for two different tropical cyclones since 1946. Lionrock and Kompasu brought heavy rain and high winds to Hong Kong, causing two deaths and at least 34 others injured in total.

Hong Kong, China reported on FIFTEEN major initiatives in support of Typhoon Committee Priorities. Notable achievements include the continued deployment of tropical cyclone surveillance flights in the Hong Kong Flight Information Region and the drifting buoys over the South China Sea and western North Pacific, coordination of WC SIGMET among neighboring MWOs, development of crowdsourcing to gather non-conventional weather reports and development of machine learning in tropical cyclone intensity forecast.

3.5 Japan

In 2021, 11 tropical cyclones (Surigae, Choi-wan, Champi, In-fa, Nepartak, Lupit, Mirinae, Omais, Chanthu, Mindulle and Malou) of tropical storm intensity or higher had come within 300 km of the Japanese archipelago as of 5 November 2021. Maximum wind speeds of 38.0 m/s in the Muroto City of Kochi Prefecture and 25.6 m/s in the Edogawa City of Tokyo were observed during the passage of Lupit. This tropical cyclone resulted in 2 fatalities as well as causing 40 injuries, 5 of which were serious. There were 2 instances of serious residential damage, 165 instances of lighter residential damage, 129 instances of flooding above floor level, and 306 instances of flooding below floor level.

Japan reported on TEN major initiatives in support of Typhoon Committee Priorities. JMA began to provide five-day 50 kt wind probability maps and charts for TDs expected to reach TS intensity or higher within 24 hours. There were several new updates on JMA's numerical weather prediction system, and full operation of the tropical cyclone communication system. JMA also continued to organize attachment training, and collaborated with ICHARM to share in ICHARM International Flood Initiative e-learning workshop. Japan continued to host the 10th WGH Meeting virtually. 46 attendees from 12 Members participated in this meeting.

3.6 Lao PDR

In 2021, Lao PDR was directly impacted by four tropical cyclones (Koguma, Conson, Dianmu and Kompasu) and indirectly by one tropical cyclone (Cempaka). In term of rainfall, tropical storm Koguma was the wettest tropical storm affecting Lao PDR. About 150 – 300 millimeters of rainfall (5 days accumulate rainfall) was generally recorded over Lao PDR during the passage of Koguma. TCs Cempaka and Conson also resulted in Mekong's tributaries reached/over danger level for 1 - 2 weeks. Besides tropical cyclone related impacts, local storms produced episodes of heavy rain, lightning, and gusty winds causing damage to infrastructure, loss of livestock, electrical outages, and property damage.

Throughout the disaster period, including pre- and post-event activities, the National Committee for Disaster Management (NDMC), headed by the Vice Prime Minister, has approached and directed the timely assistance to the affected people. NDMC also mobilized funds from the private sector and international organizations to provide assistance where needed.

3.7 Macao, China

Seven tropical cyclones (Koguma, Cempaka, Lupit, Conson, Lionrock and Kompasu) affected Macao, China between January and November 2021. The two most notable tropical cyclones were Lionrock and Kompasu. During the passage of Lionrock, heavy showers lasted for hours in Macao and caused floodings. Over 200 mm daily accumulated rainfall amount was recorded, which had become the maximum daily precipitation in October since 1952. In the case of Kompasu, a significant storm surge in Macao was induced. Flooding occurred in low-lying areas, about 0.43 m high. The blue storm surge warning was issued.

Macao reported on SEVEN major initiatives in support of Typhoon Committee Priorities. Forecast hours for individual tropical cyclone has been extended to 120 hours. SMG was also building a storm surge forecast model which collects warnings and forecasts from various sources and features from tropical cyclones in making estimations for possible occurrences of storm surges. The contents of tropical cyclone news and forecast information have been enriched so that public could be reminded to take suitable precautions against tropical cyclones and also their meteorological knowledge could be instilled. SMG also participated in civil protection drill "Crystal Fish 2021" this year with other members of the civil protection structure to prepare for the tropical cyclone season.

3.8 Malaysia

For the period from 1 November 2020 through 31 October 2021, eight tropical cyclones (Etau, Vamco, Krovanh, Surigae, Conson, Dianmu, Lionrock and Kompasu) entered the area of responsibility of the Malaysia Meteorology Department (MET Malaysia). Due to the tail effect of tropical cyclones, the consequences of typhoons and tropical storms on the Malaysian region were restricted to rain and gust occurrences. In addition to strong winds and heavy rains, high waves accompanied by storms also hit the coastal areas of

Malaysia facing the SCS and Sulu Sea. Flash floods in Malaysia represents more than 80% of total flood events. The most notable flash flood event in 2021 occurred on 18 August in Mount of Jerai, Kedah. The flash flood disaster happens due to high intensity of rainfall in 2 to 7 hours. The flood worsens when high flows carried timber and sediment from the mountain. The depth of flood is between 0.1 to 1.1 meters and the total rainfall recorded at the Gunung Jerai rainfall station is 281 mm for a period of 8 hours.

Malaysia reported on THREE major initiatives in support of Typhoon Committee Priorities representing each of the three main Working Groups. MET Malaysia continues to refine the Radar Integrated Nowcasting System (RaINS). MET Malaysia also submitted a proposal to the Typhoon Committee requesting a budget for the RaINS to conduct a training/workshop of RaINS. Moreover, the Department of Irrigation and Drainage is conducting a study to identify the gap and deficiencies of the current Hydrological Data Management System in terms of data collection, transmission and processing especially for missing and erroneous of hydrological data.

3.9 The Phillipines

As of November 2021, there were 14 tropical cyclones entered the Philippine Area of Responsibility (PAR), seven of which made landfall (Dujuan, Choi-wan, Conson, Chanthu, Kompasu and two depressions Crising and Lannie which were not officially named by RSMC Tokyo and thus adopted the local names). They caused widespread impacts like Flooding and landslides, which results in damages to infrastructures and agricultures.

PAGASA reported ONE major initiative supporting Typhoon Committee priorities. It is the improvement of the performance and impacts of South China Sea typhoon model (AOP2 of WGM).

3.10 Republic of Korea (ROK).

For the 2021 Western North Pacific Typhoon Season, there were 3 tropical cyclones (Lupit, Omais and Chanthu) which impacted the Korean Peninsula through 25 November, with Omais making landfall. Typhoons Omais and Chanthu produced the most significant damage to ROK from heavy winds and floods. During the passage of Omais, there were some damage to the ports and a few of local landslides occurs. The government estimated the cost of recovery for damage caused by Omais in nine cities and provinces of Korea at 104.9 billion KRW. In addition, more than 1,100 mm of heavy rain fell on Mt. Halla, located in the center of the Island for six days due to Typhoon Chanthu. In addition, the rainy season in Korea, a little later than usual, started in early July. Within five days of the start, more than 600 mm of accumulated precipitation occurred in Jeolla-do and Gyeongsan-do, the southern region of Korea. In particular, in Jeollanam-do, three people were killed and more than 500 houses were inundated due to flooding.

ROK reported on TWELVE major initiatives supporting Typhoon Committee Priorities. Service improvements includes extended tropical depression forecast, rapid scan service of GEO-KOMPSAT-2A and improvement of the algorithm of Typhoon Summer Prediction. ROK continues to work for the improvement of hydrological data quality

control in Typhoon Committee members and enhance capability in national flood forecasting and management by increasing the amount of flood warning and flood information points.

Two notable initiatives supported each year by the National Disaster Management and Research Institute (NDMI) had to be postponed due to COVID-19 travel restrictions. The installation of NDMI-supported Flood Alert System and Automatic Rainfall Warning Systems in Lao PDR will be rescheduled to a future date. The seminar to share the DRR knowledge of DRR in Palau was also postponed.

3.11 Singapore.

Due to its geographic location close to the equator, Singapore is rarely impacted directly by tropical cyclones. During the 2021 Pacific Typhoon season, there was an occasion where tropical storm (Dianmu) had an indirect influence on the weather in Singapore. During this period, Singapore experienced two consecutive spells of Sumatra squalls on 21 and 22 September, as prevailing winds converged around the surrounding region of Singapore under the influence of the tropical storm. The Sumatra squalls developed over the Strait of Malacca before moving eastward and affected Singapore in the early hours on 21 September, and in the pre-dawn hours on 22 September. The squalls were however not well-organised and did not result in significant heavy rain or strong winds in Singapore.

Singapore reported on SIX major initiatives supporting Typhoon Committee Priorities. Singapore, along with other Typhoon Committee Members and Indonesia, continues to strongly support the ASEANCOF and SEA RCC-Network. Internally, Meteorological Services Singapore (MSS) continuously enhanced weather observation network particularly over Singapore Changi International Airport with the replacement and upgrade of the Automated Weather Observing System (AWOS). MSS also continued active collaboration with the National Water Agency to assist in water supply management. Singapore continuously reviews and upgrades drainage infrastructure to ensure an effective drainage network for flood alleviation and prevention.

3.12 Thailand.

From 1 November 2020 to 31 October 2021, one significant tropical cyclone (Dianmu) directly affected Thailand. Nine other tropical cyclones (Goni, Etau, Vamco, Koguma, Cempaka, Conson, Lionrock and Kompasu) had indirect impacts on rainfall in Thailand over the same period. During the passage of Dianmu, Thailand's DDPM reported that 33 provinces were affected, 228 districts, 1,216 subdistricts, 8,337 villages and 1 municipality; affected 341,710 households with 35 fatalities.

Thailand reported on THREE major initiatives supporting Typhoon Committee Priorities. The Thailand Meteorological Department (TMD) joined the subcommittee on the preparation of strategies to implement the international convention obligations of the International Maritime Organization. National Water Administrative Center applied the real-time flood forecast model to alert flood situation in the Chi River Basin and inform the related agencies. Two significant projects were carried out by National Disaster Warning Center (NDWC) Thailand Department of Disaster Prevention and

Mitigation (DDPM), including additional installation of warning tower system for risk area project, and change of warning from central (NDWC, DDPM) to provincial warning project.

3.13 United States of America.

In the central North Pacific, the 2021 tropical cyclone season featured below normal activity across the RSMC Honolulu area of responsibility (AOR) with three tropical cyclones entered the central North Pacific during the period from 1 January through 15 November 2021 (Felicia, Jimena, and Linda). The region experienced persistent near to below normal rainfall, which is typical for La Nina ENSO. For the western North Pacific, there were eighteen tropical cyclones in the WFO Guam AOR during the first ten months of 2021, near the normal. Only 3 tropical cyclones (Surigae, Omais, Mindulle) threatened populated areas. Despite periods of heavy rainfall and tropical storm force winds associated with these tropical cyclones, no significant damage or injuries were reported on the affected islands. With rainfall through October 2021 near normal, a significant amount of rainfall came from periods of strong monsoon activity, especially for the western islands, rather than from the passage of tropical cyclones.

The USA reported on NINE major initiatives supporting Typhoon Committee Priorities. The USA continues to expand their Weather Ready Nation initiative by recruiting new WRN Ambassadors in their AOR. WRN Ambassadors act as message amplifiers for NWS products and services, watches, warnings, and advisories. Extensive outreach and education efforts include annual tropical cyclone exercises, tropical cyclone workshops, and StormReady/TsunamiReady programs. RSMC Honolulu conducted several Emergency Management Briefings during the 2021 hurricane season through video conferencing.

3.14 Viet Nam.

From 1 January to 30 November 2021, 5 tropical cyclones (Tropical Depression in July, Koguma, Dianmu, Lionrock, Kompasu) directly impacted the Vietnamese mainland. Koguma and Kompasu were the most intense tropical cyclones to affect Viet Nam, making landfall with wind force 9, wind gust up to force 10. As a result of tropical storm Dianmu, three people were missing, three people were injured, with about 2800 houses were damaged and 5 schools were destroyed. During the dry season of 2020-2021, there was no flood situation in the downstream of the Mekong River leading to saline intrusion occurrence in the Mekong Delta area. However, salinization situation was less severe than that in the dry season 2019-2020.

Viet Nam reported on THREE major initiatives supporting Typhoon Committee Priorities, including the development of Central Data Hub, HPC and forecast supporting system. In 2021, radar data was also assimilated experimently for improving short range heavy rainfall forecast in the WRF-ARW at 3km horizontal resolution. VNMHA continues to move toward impact-based forecasts and risk-based warnings which changes the way of information design and delivery to the disaster risk management section, local governments and the public through traditional media (TV, printed papers) as well as social media and online papers. Moreover, Viet Nam continues to support the WMO Severe Weather Forecasting Project (SWFP) for Southeast Asia (SeA)

through the Hanoi Regional Forecasting Support Centre.