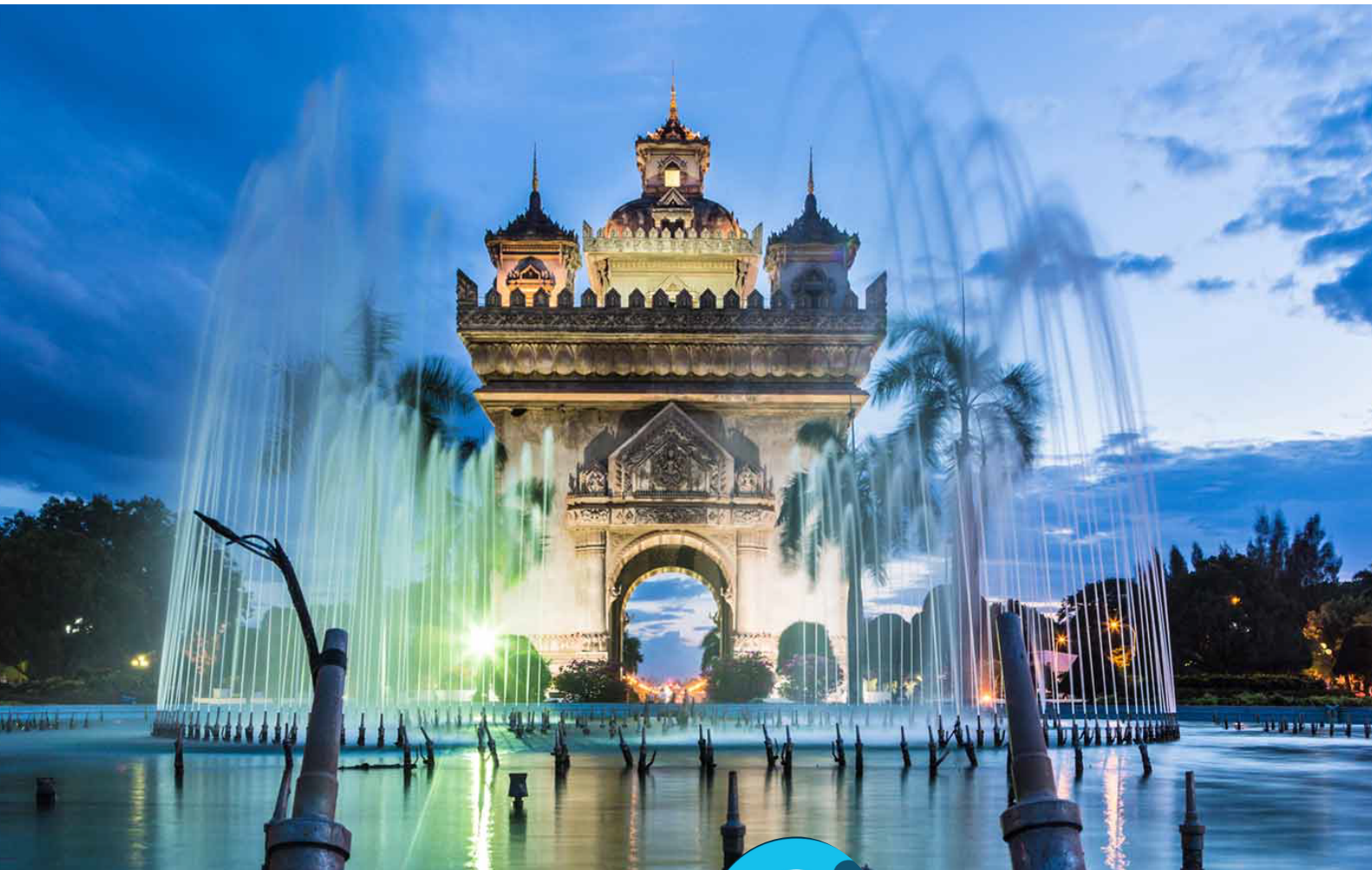




ESCAP/WMO
Typhoon Committee



VIDEO CONFERENCE REPORT OF THE FIFTY-FOURTH SESSION OF TYPHOON COMMITTEE



HOSTED BY LAO PDR
23-25 March 2022

54

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VIDEO CONFERENCE

REPORT OF THE FIFTY-FOURTH SESSION OF TYPHOON COMMITTEE

Hosted by Lao PDR
23-25 February 2022

PART I – DECISIONS OF THE COMMITTEE

1. The Committee decided to:
 - a. Elect Madam Outhone PHETLUANGSY, Director-General of Department of Meteorology and Hydrology (DMH), Ministry of Natural Resources and Environment of Lao PDR as Chairperson; Mr. LEONG Weng Kun, Director of Macao Meteorological and Geophysical Bureau of Macao, China as Vice-Chairperson and Mr. Eric LAU, Chief, Environmental Scientific & Services Division, Pacific Region National Weather Service, National Oceanic and Atmospheric Administration (NOAA), USA as Chairperson of the Drafting Committee.
 - b. 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 Strategic Plan Priorities to mitigate future impacts.
 - c. Adopt Section 2 of the Summary of Members' Reports 2021 as an "Executive Summary" to be distributed to Members' governments for information and reference.
 - d. Approve the Typhoon Committee Operational Manual (TOM) with the amendments provided in **Appendix XIX**.
 - e. Approve the recommendations submitted by Working Group on Meteorology (WGM) as expressed in paragraph 55.
 - f. Approve the recommendations submitted by Working Group on Hydrology (WGH) as expressed in paragraph 80.
 - g. Approve the recommendations submitted by Working Group on Disaster Risk Reduction (WGDRR) as expressed in paragraph 88.
 - h. Approve the recommendations submitted by Training and Research Coordination Group (TRCG) as expressed in paragraph 96.
 - i. Approve the recommendations provided by the TCS as expressed in **Appendix XIV**.
 - j. Approve the recommendations submitted by Advisory Working Group (AWG) as expressed in paragraph 103.
 - k. Approve the Strategic Plan 2022-2026 as shown in **Appendix XVI**.
 - l. Approve the Draft Agreement on Technical Cooperation and Research Activities between Typhoon Committee (TC) and the Asia Pacific Typhoon Collaborative Research Center (AP-TCRC) as shown in **Annex A, Appendix XVII**.

- m. Approve the draft Time-bound Pilot Project of the Technical Cooperation and Research Activities between TC and the AP-TCRC as show as **Annex B, Appendix XVII**.
- n. Request TCS to make arrangements for the logistics on the signing of the Draft Agreement and Time-bound Pilot Project on Technical Cooperation and Research Activities between TC and the AP-TCRC.
- o. Accept the kind offer of Macao, China to host TCS for another four-year period from 2023-2026.
- p. Approve PEILOU. PENHA, NARRA, GAENARI and BANG-LANG as replacement names for LINFA, VONGFONG, MOLAVE, GONI and VAMCO, respectively, in the list of tropical cyclone names.
- q. Approve the 2022/2023 Budget as presented below (see **Appendix XXV** for detail):

By Group	Apr-Dec2022/ Jan-Mar2023
	Proposed
TCS	25,000.00
ALL WGS (IWS ONLY)	68,000.00
TRCG	11,000.00
WGM	38,000.00
WGH	25,000.00
WGDRR	12,000.00
TOTAL	179,000.00
<i>Plus</i>	
Special Request Budget for WGs	14,000.00
Total	14,000.00
Total Proposed Budget plus Special Request Budget in 2022/2023	193,000.00

- r. Accept the venue for hosting the 17th IWS in 2022 at ESCAP facility in Bangkok, Thailand. The final date and arrangements will be confirmed in due course by TCS and ESCAP.
- s. Accept the kind offer of Macao, China to host the 55th Session in 2023. The final date and place will be confirmed in due course by Macao, China and later communicated to TCS.
- t. Request AWG to discuss the hosting arrangements for the 18th IWS in 2023, due to the unavailability of Cambodia in hosting.
- u. Accept the kind offer of Malaysia to host the 56th Session in 2024. The final date and place will be confirmed in due course by Malaysia and later communicated to TCS.
- v. Request ESCAP and TCS to continue to communicate with Members through their diplomatic channels in addition to their WMO Permanent Representatives, for Members to identify their delegations to a TC Session.

PART II – PROCEEDINGS OF THE COMMITTEE

I. ORGANIZATION OF THE VIDEO CONFERENCE (VC) (agenda 1)

2. Originally planned to be conducted face-to-face in Lao PDR, the 54th Session of the ESCAP/WMO Typhoon Committee (TC54) was proposed to be held virtually by the AWG, in consultation with Lao PDR, due to the travel restriction and quarantine measures associated with the still ongoing COVID-19 pandemic. With the approval from the Chairpersons of the 53rd Session of the Committee, the Committee decided to conduct the TC54 by video conference (VC) instead.
3. A TC54 VC hosted by Lao PDR was then scheduled from 23 to 25 February 2022.
4. The TC54 VC was attended by 142 participants from 13 out of 14 Members of the Typhoon Committee, namely: China; Democratic Republic of Korea (DPRK), Hong Kong, China; Japan; Lao People's Democratic Republic (Lao PDR); Macao, China; Malaysia; the Philippines; Republic of Korea (ROK); Singapore; Thailand; United States of America (USA); and the Socialist Republic of Viet Nam. Representatives of United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), World Meteorological Organization (WMO) and Typhoon Committee Secretariat (TCS) also attended the VC.
5. The TC54 VC was also attended by observers from the Asian Disaster Reduction Center (ADRC); International Federation of Red Cross and Red Crescent Societies (IFRC); Tohoku University of Japan and USA's Joint Typhoon Warning Center (JTWC). The list of participants can be consulted in **Appendix I**.

Opening of the Session

6. The opening ceremony of the Session began at 09:30 am HKT on Tuesday, 23 February 2022. Ms. Denise LAU from the TCS conducted the roll call, house rules and opening ceremony.
7. The following speeches were delivered at the opening ceremony and are provided in **Appendix II**:
 - a) **Mr. OBAYASHI Masanori**, Director-General of the Atmosphere and Ocean Department, Japan Meteorological Agency (JMA), on behalf of Mr. HASEGAWA Naoyuki, the Chairperson of the 53rd Session of the Typhoon Committee;
 - b) **Mr. Cyrille HONORÉ**, Director of Disaster Risk Reduction and Public Services Branch, Services Department, WMO;
 - c) **Mr. Sanjay SRIVASTAVA**, Chief, Information and Communications Technology, Disaster Risk Reduction (IDD), ESCAP;
 - d) **Mr. YU Jixin**, Secretary of Typhoon Committee;
 - e) **Madam Outhone PHETLUANSKY**, Director General of Department of Meteorology & Hydrology (DMH) of Lao PDR, declared the VC Session opened.
8. The 2021 Dr. Roman L. KINTANAR AWARD for typhoon related disaster mitigation was awarded to Department of Meteorology & Hydrology (DMH) of Lao PDR. This well-deserved award is in recognition of their outstanding contribution in severe weather response enhancement and nationwide flood forecasting and early warning system.
9. The Committee took note that the Dr. Kintanar Award Plaque Ceremony will be held when the Session is able to meet face-to-face.

II. REPORT ON CREDENTIAL COMMITTEE (agenda item 2)

10. Ms. Denise LAU, Senior Secretary of TC, presented the Credential Letters submitted by TC Members and presented the Summary Report of the Credential Committee, which can be consulted at **Appendix III**.

III. ELECTION OF OFFICERS (agenda item 3)

11. Madam Outhone PHETLUANGSY, Director-General of DMH, Ministry of Natural Resources and Environment of Lao PDR, was elected Chairperson and Mr. LEONG Weng Kun, Director of Macao Meteorological and Geophysical Bureau of Macao, China was elected Vice-Chairperson of the Committee.
12. Mr. Eric LAU, Chief, Environmental Scientific & Services Division, Pacific Region, National Weather Service, NOAA of USA, was elected Chairperson of the Drafting Committee.

IV. ADOPTION OF THE AGENDA (agenda item 4)

13. The Committee adopted the agenda for the TC54 VC. (**Appendix IV**)

V. TECHNICAL PRESENTATIONS (agenda item 5)

5.1 Summary of the 2021 typhoon season

14. The Committee noted with appreciation the review of the 2021 typhoon season provided by the RSMC Tokyo as provided in **Appendix V**, whose summary is presented in paragraphs 15 – 25.
15. In the western North Pacific and the South China Sea, 22 named tropical cyclones (TCs) formed in 2021, which was below the 30-year average (25.1, averaged for the 1991 – 2020 period) and nine out of them reached typhoon (TY) intensity, which was below the 30-year average (13.3). Eight named TCs formed from August to September (the peak formation period), which was also less than the normal of 10.7, mainly due to inactive convection over the sea, where TCs frequently form. The lower number of formations during the peak period may have contributed to the reduced annual total.
16. The second named TC, Surigae (2102), formed over the Caroline Islands at 18 UTC on 12 April 2021 and reached peak intensity with maximum sustained winds of 120 kt (the highest for April since statistics began in 1977) and a central pressure of 895 hPa east of the Philippines at 18 UTC on 17 April. It brought moderate-to-heavy rain over the Eastern Visayas region.
17. 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 genesis point of named TCs formed in summer (June to August) was 21.5°N and 129.8°E, with a west-northwestward deviation from that of the 30-year summer average (18.5°N and 134.2°E), and that of named TCs formed in autumn (September to November)

was 14.4°N and 133.6°E, which was a west-southwestward deviation from that of the 30-year autumn average (16.2°N and 137.0°E). The westward shift of the mean genesis point from the autumn onward is partly due to the La Niña event which persisted through the tropical cyclone season.

18. The mean duration of TCs sustaining tropical storm (TS) intensity or higher was 5.5 days, longer than that of the 30-year average (5.2 days). The mean duration of TCs sustaining TS intensity or higher formed in summer was 4.6 days, shorter than that of the 30-year average (5.0 days), and the mean duration of TCs sustaining TS intensity or higher, which formed in autumn was 5.7 days, longer than that of the 30-year average (5.4 days).
19. Dujuan (2101) – the first named TC of 2021 – formed in February as a tropical depression (TD) over the sea around the Caroline Islands (here, TC locations are expressed as the area of TD formation unless otherwise noted). The second – Surigae (T2102) – formed in April over the sea around the Caroline Islands and developed to TY intensity with a peak intensity of maximum sustained winds of 120 kt and a central pressure of 895 hPa (a record for the 2021 season), The third – Choi-wan (2103) – formed in May over the sea around the Caroline Islands and passed over the central part of the Philippines in early June.
20. The two named TCs in June were Koguma (2104), which formed over the South China Sea and crossed Hainan Island with TS intensity before hitting northern Viet Nam and causing floods along its path, and Champi (2105), which formed around the Chuuk Islands.
21. Three named TCs formed in July. The first, In-fa (2106) formed over the sea east of the Philippines and developed to TY intensity, affecting Japan, the Philippines and China with torrential rain, strong winds and high waves, resulting in flooding over wide areas. Cempaka (2107) then formed over the South China Sea, and after developing to TY intensity hit southern China with severe tropical storm (STS) intensity. Nepartak (2108) subsequently formed over the sea around the Ogasawara Islands and made landfall on the Pacific side of northern Japan.
22. Four named TCs formed in August. Lupit (2109) formed over the South China Sea and hit southern China, crossed the Taiwan Strait and made landfall on the southern part of Kyushu in Japan. After moving over Seto Inland Sea, it made landfall again in Hiroshima Prefecture, bringing torrential rain to areas in its path. Mirinae (2110) formed over the sea south of Okinawa and Nida (2111) formed over the sea around the Ogasawara Islands, with both transitioning into extratropical cyclones over the sea far off east of Japan. Omais (2112) formed over the sea east of the Philippines and reached peak intensity before crossing the southern part of the Korean Peninsula, bringing heavy rain and flooding.
23. Four named TCs formed in September. The first, Conson (2113) formed over the sea east of Mindanao Island and crossed the Philippines before moving over the South China Sea. Chanthu (2114) then formed over the sea around the Mariana Islands and reached TY intensity over the sea east of the Philippines. After a complex progression over the East China Sea, it made landfall on Japan and also affected the Philippines, the Republic of Korea and Japan. Dianmu (2115) subsequently formed over the South China Sea and hit Viet Nam, then weakened and moved to Laos and Thailand, resulting in plentiful rain, flooding and landslides in these regions. Mindulle (2116) then formed over waters near the Mariana Islands and was upgraded to TY intensity over the sea east of the Philippines.

Accelerating north-eastward, it brought strong winds and heavy rain to the south-eastern part of Japan's Kanto region.

24. Four named TCs formed in October. The first, Lionrock (2117), formed over the South China Sea and hit northern Viet Nam, affecting several regions along its path. Kompasu (2118) then formed over the sea east of the Philippines, and after crossing Hainan Island also hit Viet Nam. Heavy rain and strong wind were reported in the Philippines, China and Hong Kong China. Namtheun (2119) formed over the sea south-southwest of Wake Island and developed into STS intensity. Malou (2120) formed over the sea southwest of Guam Island and reached TY intensity over the sea south of Japan. After transitioning into an extratropical cyclone, both Namtheun and Malou crossed longitude 180 degrees east.
25. The one named TC for November was Nyatoh (2121), which formed over the sea south-southwest of Guam Island, developed to STS intensity and transitioned into an extratropical cyclone over the sea east-northeast of the Ogasawara Islands. The last-named TC, Rai (2122) formed in December over the sea around the Caroline Islands and crossed the Philippines with TY intensity and brought intense wind and heavy rain.

VI. REPORT ON TC'S KEY ACTIVITIES AND OVERVIEW SUMMARY OF MEMBERS' REPORTS (agenda item 6)

6.1 Report on TC's Key Activities and Main Events in the Region

26. The Committee took note of the report of the Typhoon Committee Chairperson on the TC's Key Activities and Main Events in the Region, 2021 (**Appendix VI**)
27. Noting the successful implementation of many activities during the COVID-19 pandemic, the Committee requested AWG to consider how to implement future activities including IWS in a more efficient and effective manner, using virtual, in-person and hybrid meetings/events.
28. The Committee expressed sincere appreciation to the contributions of Mr. HASEGAWA Naoyuki and Madam Outhone PHETLUANGSY, as the Chairperson and Vice Chairperson of the Committee.

6.2 Overview Summary of Members' Reports

29. 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. (**Appendix VII**)
30. 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

31. The Committee considered the key tropical cyclone impacts on Members in 2021 and reviewed the initiatives and activities to be pursued in support of the 21 TC Strategic Plan Priorities to mitigate future impacts.
32. The Committee adopted Section 2 of the Summary of Members' Reports 2021 as an "Executive Summary" to be distributed to Members' governments for information and reference.

VII. REVIEW OF ACTIVITIES OF RSMC TOKYO AND AMENDMENTS OF TOM (agenda item 7)

7.1 Review of the activities of the Regional Specialized Meteorological Center (RSMC) Tokyo 2021 (Appendix VIII)

33. The Committee noted with appreciation the review of RSMC advisories, products and operational activities and changes made in 2021. It noted the forecast verification results for 22 TCs that reached TS intensity or higher formed in 2021: the forecast track errors of the year of 87 km (74 km in 2020), 157 km (119 km), 225 km (176 km), 261 km (214 km) and 264 km (267 km) for 24-, 48-, 72-, 96- and 120-hour forecasts, respectively, the annual mean RMSEs for central pressure forecasts of 11.9 hPa (11.6 hPa), 15.9 hPa (15.0 hPa), 18.0 hPa (14.6 hPa), 19.0 hPa (13.9 hPa) and 17.9 hPa (13.0 hPa) for 24-, 48-, 72-, 96- and 120-hour forecasts, respectively, and those for maximum wind speed forecasts for 24-, 48-, 72-, 96- and 120-hour forecasts of 5.0 m/s (5.8 m/s), 6.5 m/s (7.0 m/s), 6.9 m/s (7.3 m/s), 7.6 m/s (7.2 m/s) and 8.2 m/s (6.8 m/s) respectively.
34. The Committee noted with appreciation the changes in RSMC advisories, products and operational/coordination activities made in 2021, especially the commencement of five-day 50-kt wind probability map provision for tropical depressions (TDs) expected to reach tropical storm (TS) intensity or higher within 24 hours and enhanced tropical cyclone verification.
35. The Committee noted with appreciation the operation of RSMC Tokyo's Numerical Typhoon Prediction (NTP) website, and noted changes made in 2021 as well as those planned for the near future.
36. The Committee noted with appreciation RSMC Tokyo's maintenance of a dedicated platform for enhanced communication between operational forecasters and RSMC Tokyo, as well as the sharing of advance-notice updates. Full-scale operation of the platform was started during the 2021 typhoon season and at least 15 inquiries relating to tropical cyclones have been submitted, with related discussion helping to clarify TC status and forecasts.
37. The Committee noted with appreciation the contribution of RSMC Tokyo (which also serves as an International Civil Aviation Organization (ICAO) Tropical Cyclone Advisory Centre (TCAC Tokyo)) to comply with ICAO Standards and Recommended Practices (SARPs), addressing the provision of TCA information in text, graphical and ICAO Meteorological Information Exchange Model (IWXXM) 3.0 formats via multi-platform channels such as the TCAC Tokyo website.

38. The Committee noted with appreciation the ongoing contribution of RSMC Tokyo to the regional Storm Surge Watch Scheme (SSWS), especially the provision of various products including storm surge forecast distribution maps, time-series charts for selected stations and multi-scenario storm surge predictions, as well as week-range probabilistic wave forecasts for significant wave heights and peak wave periods. The Committee again encouraged Members to make their sea level observation data available in order to support verification activity. The Committee was informed that SSWS products are scheduled to be upgraded in 2022.
39. The Committee noted with appreciation the continuous efforts and progress of RSMC Tokyo's development of tropical cyclone genesis guidance using early Dvorak Analysis and global ensemble.
40. The Committee was pleased to note the progress of the regional radar network development project, under which experimental exchange of radar composite data among Japan, Thailand and Malaysia that started in 2016. The project has been expanded, and three more Members (Lao PDR, the Philippines and Viet Nam) joined in 2018. The Committee noted with appreciation the progress made on regional radar data exchanges, especially the creation of a sample regional composite map consisting of participating Members' radar data in 2021, and the User's Guide on Introduction and Utilization of Quantitative Precipitation Estimation (QPE) drafted by Thailand, Malaysia and Japan.
41. The Committee was pleased to note the activities of the project for enhancing the utilization of Himawari-8/9 products, under which technical support for developing Rapidly Developing Cumulus Area (RDCA) identification using Himawari-8/9 data are provided. The Committee noted with appreciation the ongoing discussion and support engaged between experts from Malaysia and Japan. It also expressed appreciation for efforts made in an online technical meeting attended by experts from Singapore, Thailand and Viet Nam in February 2020, and JMA's consideration for progress, including another meeting in February 2022 to share information on RDCA detection techniques. The Committee also noted that HCAI (High-resolution Cloud Analysis Information) data and Atmospheric Motion Vector (AMV)-based Sea-surface Wind data are provided to NMHSs every 10 minutes.
42. The Committee noted with appreciation RSMC Tokyo's publication of its Technical Review No. 23 and the Annual Report on the Activities of the RSMC Tokyo Typhoon Center 2020 in April and December 2021, respectively.
43. The Committee was informed that RSMC Tokyo had started tropical cyclone satellite re-analysis in 2012 for the period from 1981 onward to enable evaluation and improvement regarding the quality of the Current Intensity (CI) number in satellite TC analysis. It also acknowledged that the Center has almost completed the reanalysis along with basic quality checking (QC) for the period from 1987 to 2016. In line with the need for additional QC, the Committee was also informed that RSMC Tokyo will share the whole dataset for the period from 1987 to 2016 with Members in 2022.
44. The Committee noted with appreciation that the operation of Himawari-8/9 geostationary meteorological satellites and further welcome the intention of RSMC Tokyo to continue providing Himawari products as well as technical support for using them. The

Committee was informed that the switchover from Himawari-8 to -9 is scheduled to take place around December 2022.

45. The Committee noted with appreciation RSMC Tokyo's virtual hosting of the 20th Attachment Training session from 9 to 11 March 2021 with 44 attendees from seven Members (Hong Kong China, Macao China, Malaysia, the Philippines, the Republic of Korea, Singapore and Thailand) to support understanding of up-to-date public weather services as well as conventional TC monitoring, analysis and forecasting techniques. The Committee also noted with appreciation the hosting of the 21st course (11 – 13 January 2022) with 55 attendees from eight Members (China, Hong Kong China, Macao China, Malaysia, the Republic of Korea, the USA, Thailand and Viet Nam). The 2022 session included presentations on state-of-the-art TC analysis techniques by distinguished invited lectures and exercises on satellite image analysis. The course helped attendees to learn more about TCs for application in operational services.
46. The Committee noted for RSMC-Tokyo's regular monitoring of observation data exchanges in 2021 as per the Typhoon Committee Operational Manual's Meteorological Components (TOM), with results to be provided by March 2022. The Committee expressed appreciation to all Members providing special observation data to Committee Members in 2021, and further encouraged all Members to conduct additional observation as requested by TOM.

7.2 Typhoon Committee Operational Manual (TOM)

47. The Committee noted that the Typhoon Committee Operational Manual (TOM) rapporteur requests WMO to publish and upload the 2022 edition of TOM on the Tropical Cyclone Programme (TCP) Website as submitted by the Rapporteur, with the amendments given in **Appendix IX**.
48. The Committee expressed its appreciation to the rapporteur for update of TOM.

VIII. REPORTS OF TC WORKING GROUPS AND TRCG (agenda item 8)

49. Parallel sessions of the Working Groups (WG) on Meteorology (WGM), Hydrology (WGH) and Disaster Risk Reduction (WGDRR) as well as the Training and Research Coordination Group (TRCG) were convened during the WG's individual online meetings and during the online 16th IWS to review progress of work during the past year, identify priorities for cooperation and make recommendations to the Committee.
50. The outcomes of the parallel sessions of the three WGs and TRCG were reported to the plenary session as given in the following sections.

8.1 Meteorological Component

51. The Committee took note of the Member's activities and major progress and issues in Meteorological Component in 2021 as reported by Members at the 16th IWS.

52. The Committee reviewed the activities of Members in implementing the TC Strategic Plan and its annual operating plan in relation to Meteorological Component during past year, details of which are presented in **Appendix X**.
53. The Committee took note of the outcomes of the WGM Parallel Session at the 16th IWS on 2-3 December 2021. With the assistances of TCP/WMO and TCS and the strong support from all Members, WGM has successfully completed the tasks in 2021 with significant outcomes as follows:
- a) WGM has fulfilled all the action plans (5 Perennial Operating Plans (POPs), 9 Annual Operating Plans (AOPs) and 2 Preliminary Projects (PPs)) in 2021, which were endorsed at the 53rd TC Session.
 - b) Since the outbreak of COVID-19 in early 2020, the impacts of the COVID-19 pandemic have been deep and wide. Some activities in WGM such as research fellowships, technical transfer and meetings have been either cancelled or postponed due to global travel restrictions and border closure as well as strict social distancing measures in many countries/places.
 - c) After the 53rd TC Session in 2021, WGM has been carrying out the following activities that involve the cooperation among Members as well as other TC WGs and international organizations:
 - i. Coordinated with the Shanghai Typhoon Institute (STI) to organize the fourth WGM Annual Meeting by video conferencing on 28 October 2021.
 - ii. Coordinated with China Meteorological Administration (CMA) for the online International Training Course “Sixth International Distance Training Course on Tropical Cyclone Monitoring and Forecasting” to be held from 25 November to 3 December 2021.
 - iii. Coordinated with TRCG to host the 2021 research fellowship by the Hong Kong Observatory (HKO) on a topic entitled “Verification of tropical cyclone wind structure forecasts from global NWP models and ensemble prediction system” via a remote approach.

Conclusions of WGM

54. On the basis of the information provided by Members and the respective coordinator of the actions plan and based on the discussion during the 16th IWS, the following conclusions were reached:
- a) Members have made important progress in the implementation of the TC Strategic Plan during the year 2021.
 - b) Members made significant progress during 2021 in tropical cyclone monitoring and communication systems, data assimilation and numerical weather prediction systems, tropical cyclone forecast-aiding systems, and scientific understanding of tropical cyclone activities.
 - c) With the help of Tropical Cyclone Programme (TCP) of WMO and Typhoon Committee Secretariat (TCS), and the absolute sincere cooperation of all Members and the effective efforts of the WGM focal points, WGM has successfully completed the tasks in 2021.
 - d) The 4th WGM Annual Meeting was held online on 28 October 2021. Major results of the meeting were reported during the WGM parallel session in the 16th IWS.

- e) Based on the discussion on the operating plans for 2021 during the 16th IWS, it was concluded to adopt the operating plans as follows:
 - i. The POP item 1-3 will be continued in 2022.
 - ii. The POP item 4 will be closed.
 - iii. The POP item 5 will be renamed as item 4 and continued in 2022.
 - iv. The AOP item 1-9 will be continued in 2022.
 - v. The PP item 1-2 will be continued in 2022.
- f) The total budget proposed by WGM, which was concurred at the AWG meeting during the 16th IWS, for undertaking the operating plans (AOPs, POPs and PPs) in 2021 is USD\$38,000. In addition, the budget of USD\$12,000 will be allocated for the cross-cutting project (PP1) between WGM and TRCG.
- g) The complete WGM 2022 operating plans (AOPs, POPs and PPs) including the actions, the success indicators, coordinators and budget is listed in **Appendix X**.

Recommendations of WGM

- 55. On the basis of the deep discussion and communication, WGM agreed to submit the following recommendations to the Committee at TC 54th Session as follows:
 - a) To request Korea Meteorological Administration (KMA) to improve typhoon summer prediction techniques and provide information via e-mail for Members in late May.
 - b) To request CMA to encourage TC Members to join the Collaborative Discussion (CoDi) Forum for real-time typhoon discussion and information exchange.
 - c) To request STI to publish the TCRR Journal on a quarterly basis in 2022, and to improve the editorial procedure and Journal's influence.
 - d) To request STI to issue summary report on verification of TC forecast products in 2021 typhoon season in western North Pacific, and plan to issue the verification results for other basins.
 - e) To request STI to strengthen international cooperation and promote the exchange of TC data and verification techniques through WMO-TLFTP.
 - f) To request JMA to further develop tropical cyclone genesis guidance using early Dvorak Analysis (EDA) and global ensemble.
 - g) To request CMA to improve the performances and impacts of TRAMS including the dynamic core, physical processes and model products.
 - h) To request JMA to further refine quality control techniques applied to the participants' radar networks to improve their quality of radar composites, and to implement and refine Malaysian Meteorological Department (Met Malaysia) and Thai Meteorological Department (TMD)'s QPE calibration using rain-gauge.
 - i) To request JMA to support applicants to join the experimental regional radar data exchange in the future, and to share the progress with RA II/V WIGOS radar project in Southeast Asia.
 - j) To request JMA to compose a user's guide among JMA, Met Malaysia and TMD.
 - k) To request JMA to hold follow-up technical meeting(s) upon receipt of progress reports on the project Development of Regional Radar Network (AOP3) from participants.

- l) To request Met Malaysia and HKO to conduct training attachment for two participants from two TC Members on Radar Integrated Nowcasting System (RaINS) in 2022.
- m) To request JMA to add storm surge time series prediction upon request from Members, and to publish verification results of storm surge predictions.
- n) To request JMA to encourage Members to provide complete hourly sea level data of at least one year to provide accurate astronomical tides at the stations.
- o) To request JMA to encourage Members to provide sea level observations during storm surge events for verification of storm surge predictions.
- p) To request JMA to upgrade the storm surge watch scheme model and renew SSWS products on the NTP website.
- q) To request CMA to implement the field campaign collaboration among participating Members by using aircraft, Unmanned Aircraft System (UAS), airship, rocket, high-resolution radar, etc.
- r) To request CMA and HKO to collect and share the field observation and research data, and to conduct demonstration research on tropical cyclone intensity change in conjunction with WMO-TLFDP.
- s) To request JMA to improve Rapidly Developing Cumulus Area (RDCA) algorithm through the joint development by JMA and Met Malaysia.
- t) To request JMA to provide support for the development of RDCA by Meteorological Service Singapore (MSS), TMD and Viet Nam Meteorological and Hydrological Administration (VNMHA).
- u) To request JMA to hold follow-up meeting(s) upon receipt of progress reports on the project Enhancing Utilization of Himawari 8/9 Products (AOP7) from participants.
- v) To request CMA to hold a special seminar on Parallel Analysis of Satellite Data in the Northwest Pacific and invite other agencies to participate.
- w) To request JMA to support AOP7 of WGH through providing 1-month and 3-month ensemble NWP model data, necessary for the project and available, to International Centre for Water Hazard and Risk Management (ICHRM), and to request JMA to share the knowledge such as characteristics and features related to NWP.
- x) To request JMA to continue sharing knowledge and experience on awareness raising through lectures for online workshops and meetings of International Flood Initiative (IFI) project.
- y) To request JMA to promote awareness with hydrological authorities to both local governments and public, including the appropriate use of products.
- z) To request Met Malaysia in cooperation with WGM and TRCG to organize a training workshop for younger operational forecasters on the new typhoon forecasting techniques, and to review the progress of WGM projects.
- aa) To request KMA to introduce Geo-Kompsat 2A (GK2A) upper-level products related to typhoon forecast and share the technique using GK2A data.
- bb) To endorse the proposed action plans in 2022 (including 4 POPs, 9 AOPs and 2 PPs) as listed in Annex II of Appendix C – Summary Report for the WGM Parallel Meeting at the 16th IWS, which summarizes the above recommendations with additional action items.
- cc) To endorse the WGM budget request included in the budget proposal to be submitted by AWG for TC's approval.
- dd) To appoint Mr. HOSOMI Takuya as the rapporteur of TOM.
- ee) To encourage project coordinators of all working groups to submit the outcome (research paper) to the TCRR journal.

8.2. Hydrological Component

56. The Committee reviewed the activities of the Members related to the implementation of the decision of TC 53rd Session and its AOP for the hydrological component during the past year. Details can be found in the **Appendix XI**.
57. The Session noted the flood-related disasters happened in 2021 and hydrological activities conducted in Members in the year, and also noted the special measures taken by Members for flood disaster risk reduction and the progresses achieved in Members under the situation of COVID-19 pandemic.
58. The Session noted with pleasure that, the video conference (VC) for 10th working meeting of Working Group on Hydrology (WGH) was organized by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) in cooperation with Infrastructure Development Institute (IDI) and International Centre for Water Hazard and Risk Management (ICHARM) of Japan on 22 October 2021. The VC was attended by more than 50 participants from 11 of 14 Members of the Typhoon Committee, namely: China; Hong Kong, China; Japan; Lao People's Democratic Republic (Lao PDR); Malaysia; the Philippines; Republic of Korea; Singapore; Thailand; USA and Viet Nam. Typhoon Committee Secretariat (TCS) and Thai Meteorological Department (TMD) of Thailand also participated in the VC. The Session expressed its appreciation to the Japan government through MLIT with cooperation of ICHARM and IDI of Japan for generously hosting the meeting.
59. The Session was informed with appreciation that the Japan is willing to host the potential face to face conference for WGH 11th working meeting in 2022, subject to the situation of COVID-19 pandemic.
60. The Session was informed that the project of "Knowledge Sharing on Storm Surge Inundation Mapping" led by Guam of USA has been put on hold indefinitely in past two years due to the limitations in travel and other problems during the COVID-19 outbreak. However, the project leader expressed that, this project will be kept on track as soon as face to face meetings are again allowed, and to continue to solicit all countries to send their interest in the program as soon as possible so that the implementation plan of this worthwhile project can be begin to make progress in 2022. The session also was informed that the project is under consideration for extension for 3 more years to the end of 2025, adjustable subject to the situation of COVID-19 pandemic.
61. Following the decisions made at TC 53rd Session, WGH tried its best to conduct the activities for implementing its following 6 AOPs in 2021 including domestic research, paper works and virtual meetings:
 - a) AOP2: Application of Hydrological Data Quality Control System in TC Members
 - b) AOP3: Enhancement of Flood Forecasting Reliability with Radar Rainfall Data and Stochastic Technique
 - c) AOP4: OSUFFIM Phase-II: Extension of OSUFFIM Application in TC Members
 - d) AOP5: Impact Assessment of Climate Change on Water Resource Variability in TC Members
 - e) AOP6: Flood Risk Watch Project for Life-saving
 - f) AOP7: Platform on Water Resilience and Disaster under IFI (International Flood Initiative)

62. The Session noted that, Han River Flood Control Office (HRFCO) of the Republic of Korea in cooperation with Korea Institute of Civil Engineering and Building Technology (KICT) conducted a series of activities for the project on Application of Hydrological Data Quality Control System in TC Members and the project on Enhancement of Flood Forecasting Reliability with Radar Rainfall Data and Stochastic Technique, including: (1) organized a joint virtual seminar on 18 November 2021 for the wrap-up of the expert mission of field survey which was conducted in 5 participating Members, namely Lao PDR, Malaysia, Philippines, ROK and Thailand in 2019, (2) upgraded the operation platforms for two projects, (3) published the technical report for hydrological data quality control management (TC/TD No. 0022). The Session also noted the implementation plans for 2022, including: (1) to finalize the establishment of the hydrological data quality control system (PC-version); (2) to develop the stochastic flood forecasting system, and (3) to publish the Manuals for two projects.
63. The Session noted that, the pilot study for the phase-II of the project on Development and Application of Operational System for Urban Flood Forecasting and Inundation Mapping (OSUFFIM-II) for TC Members continued to be conducted in China and achieved satisfactory results. Sun Yat-Sen (SYS) University of China organized and funded a special volume on the Typhoon Commission Journal “Tropical Cyclone Research and Review (TCRR). The Journal which collected 5 papers presenting the achievements of pilot studies for selected Members within the past years. The Session also noted that the pilot study will be continued in 2022, and a potential face to face workshop was scheduled in Guangzhou, China subject to the situation of COVID-19 pandemic in 2022.
64. The session was informed with appreciation that, due to the impact of COVID-19 pandemic, some scheduled activities of OSUFFIM project were postponed. Based on the communication between the leading country and participating Members, China agreed to extend this project one more year to the end of 2023 to support participating Members with completing scheduled pilot studies.
65. The Session was informed with pleasure that, a virtual training workshop was organized for the project on Impact Assessment of Climate Change on Water Resource Variability in TC Member states by the Information Centre of the Ministry of Water Resources (MWR) of China in cooperation with the Research Centre for Climate Change (RCCC) of MWR and the Nanjing Hydraulic Research Institute (NHRI) on 15 December 2021. Over 60 participants from 7 countries, namely China, Ethiopia, Malaysia, Myanmar, Korea, Thailand, and Viet Nam, attended the virtual training course and were issued the Participation Certificates jointly by TCS and RCCC. The session also noted with appreciation that Chinese institutions agreed to open and share the source code of RCCC Water Balance Model (WBM) with TC Members following the request from Members. The scheduled activities for 2022 includes: (1) to organize 1-2 on-line or/and off-line training workshops; (2) to improve RCCC-WBM model by adding a flow duration curve module; and (3) to publish the technical report before TC 17th IWS in 2022.
66. The Session noted with gratitude that, following the request from Members, China agreed to extend the project on Impact Assessment of Climate Change on Water Resource Variability for TC Members two more years to the end of 2024 for further training on RCCC-WBM model and its applications in TC Member states.

67. The Session was informed that, the schedule of the project on Flood Risk Watch Project for Life-saving in 2021, i.e. test installation of 3L Water Level Gauges (WLGs) in Malaysia was forced into suspension due to the impact of COVID-19 pandemic. The Session also noted that, Japan and Malaysia will proceed with concrete activities toward the start of 3L WLGs observation in early 2022, and will share the information about 3L WLGs to TC Member if needed.
68. The session was informed with appreciation that Japan will extend this project one more year to the end of 2023 due to the impact of COVID-19 pandemic.
69. The Session was informed that, in 2021, ICHARM of Japan conducted the following activities for the Project of Platform on Water Resilience and Disasters under IFI (International Flood Initiative), including: (1) establishing the platform on water resilience and disasters, and developing the flood forecasting system in Philippines; (2) building the Online Synthesis System (OSS) for Davao city, Philippines; and (3) organizing the E-learning workshops in Philippines and Indonesia. The Session also noted that the Hands-on Training Workshop is scheduled as the second phase of the project in 2022.
70. The Session was informed that, 5 new projects were proposed from Members as WGH new AOPs for further discussion at WGH 11th working meeting and TC 17th IWS in 2022, and to be officially launched at 55th Annual Session in 2023, including:
 - Improvement of Hydrological Data Quality Control System by using Artificial Intelligence (AI) technology from Republic of Korea.
 - Improvement of Flood Forecasting modelling by using AI technology from Republic of Korea.
 - Knowledge Sharing on the Southeast Asia Flash Flood Guidance System (SeAFFGS) from Viet Nam.
 - Flood Monitoring for Risk Reduction (tentative) from Japan
 - Flood Resilience Compatible with Sustainable Development (tentative) from Japan.
71. The Session noted with pleasure the proposed modifications of the Key Result Areas (KRAs) and Priorities related to hydrological component within the updated TC Strategic Plan 2022-2026.
72. The Session was informed with pleasure that the vice chairperson of WGH Dr. Hyo-Seob CHO was selected as a Chair of the WMO RAII Coordination Panel on Hydrology and Water Resource, and Dr. CHO expressed that he would make his contribution on enhancing the cooperation between TC WGH and RAII WGH at his position.

Conclusions of WGH

73. On the basis of the discussion and outcomes at 10th WGH working meeting and the parallel session of TC 16th IWS, participants recognized the importance in following aspects for further direction of WGH.
74. It is a consensus on that, the impact of COVID-19 pandemic may become a normal situation in due time. TC Members may need to consider how to coexist with COVID-19. In this connection, it is needed to analyze the new countermeasures under public emergencies on typhoon-related disaster risk reduction in TC Member countries for this typhoon season, Examples including monitoring, data collection, forecasting and warning, information sharing and emergency response. By summarizing the experience and coping

strategy on typhoon-related disaster risk reduction in the region of TC and other regions in the world; will provide reference and guidance for TC Members on typhoon-related disaster risk reduction under public emergencies in future. Members also may need to consider how to push the Working-Group's annual operation plan (AOP) forward under the situation of COVID-19 pandemic. It is recognized that it should be an effective measure to establish a regular mechanism for on-line activities instead of face-to-face interaction including training courses, and/or workshops, etc.

75. It is a consensus on that, the working meeting of WGH is very important for review and to push forward hydrological activities, and is very necessary to prepare for the upcoming IWS and annual session. WGH appreciated the generous contribution from Republic of Korea and Japan in the past years for hosting WGH working meetings. WGH also encouraged more Members to host its working meeting.
76. Due to the impact of COVID-19 pandemic, the virtual conference has become a normal format for WGs' annual meeting and TC IWS. Due to the limited agenda, it is very hard for AOP leaders to have enough time for deep technical discussion and explanation on WGs' meetings and TC IWS. To resolve this problem, HRFCO in cooperation with KICT organized virtual workshops special for Korea-led AOPs in the past two years. Following this good example, all AOP leading Members may need to consider on-line AOP workshops or training courses annually for their led AOPs with the purpose of deep discussion of AOP's implementation so as to keep its momentum and sustainability.
77. It is a consensus on that, to draw up a plan on considering and proposing a bank of new cooperation projects under the umbrella of TC Strategic Plan 2022-2026 in a linkage with the initiatives and activities of ESCAP and WMO, it would be an urgent matter at present for WGH. To conduct the cooperation projects sustainably for TC Members, WGH discussed and determined the list of potential topics and keywords as the priority cooperation activities for long-term direction to develop the Member's capacity on water-related disaster risk forecasting and warning.
78. WGH members recognized that the application of big data and AI technology in flood forecasting and early warning will become a mainstream and development direction in future. WGH should consider a cooperation project as its AOP on this area to enhance the application study.
79. WGH agreed to continue enhancing the cooperation with Panel on Tropical Cyclones (PTC) and other regions, under the Cooperation Mechanism between TC and PTC, through involving more participants from outside of Typhoon Committee region in WGH working meeting.

Recommendations of WGH

80. On the basis of the deep discussion and communication, participants agreed to submit the following recommendations to the Committee at TC 54th Annual Session to be held in February 2022:
 - a) to request USD\$25,000 from TCTF for supporting overall WGH activities for 2022 calendar year.
 - b) to thank MLIT, Japan in cooperation with ICHARM and IDI for hosting the video conference for WGH 10th Working Meeting on 22 October 2021.

- c) to request USA to extend the project of AOP1 (AOP1 (Knowledge Sharing on Storm Surge Inundation Mapping) three more years to the end of 2025.
- d) to request China to extend the project of AOP4 (OSUFFIM Phase-II: Extension of OSUFFIM Application in TC Members) one more year to the end of 2023.
- e) to request China to extend the project of AOP5 (Impact Assessment of Climate Change on Water Resource Variability in TC Members) two more years to the end of 2024.
- f) to request Japan to extend the project of AOP6 (Platform on Water Resilience and Disaster under IFI) one more year to the end of 2023.
- g) to request MLIT, Japan to host the face-to-face WGH 11th working meeting in Japan subject to the situation COVID-19 pandemic in 2022.
- h) to request HRFCO, Republic of Korea in cooperation with KICT to further refine the proposals of “Improvement of Hydrological Data Quality Control System by using AI technology” and “Improvement of Flood Forecasting modelling by using AI technology” for approval at TC 55th Session as WGH AOPs for 2023 and beyond.
- i) to request VNMHA of Viet Nam to further refine the proposal of “Knowledge Sharing on the Southeast Asia Flash Flood Guidance System (SeAFFGS)” for approval at TC 55th Session as WGH AOP for 2023 and beyond.
- j) to request MLIT and ICHARM of Japan to further refine the proposals of “Flood Monitoring for Risk Reduction (tentative)” and “Flood Resilience Compatible with Sustainable Development (tentative)” for approval at TC 55th Session as WGH AOP for 2023 and beyond.
- k) to request HRFCO to continue maintaining and operating the WGH webpage for effective sharing information among WGH members with support from KICT and TCS.
- l) to appoint the focal point of WGH in Republic of Korea, Mr. Yo-Han CHO, as the liaison to PTC and WMO RA II for WGH of the Committee for enhancing hydrological cooperation between TC and other regional bodies under the supervision of Dr. Hyo-Seob CHO as the Chairperson of the RAII Coordination Panel on Hydrology and Water Resources of WMO.
- m) to continue focusing on improving the ability to forecast hydrological phenomena and provide measures for the effectiveness of the improvements.

8.3. Disaster Risk Reduction Component

- 81. During the 16th IWS Working Group DRR parallel virtual meeting on December 2, 2021, the Working Group reviewed its activities and its Annual Operating Plans (AOPs) for 2021. Please refer to **Appendix XII** for details.
- 82. As the COVID-19 travel restrictions were still on throughout 2021, most of the WGD RR projects for 2021 were not able to be carried out.
- 83. Dr. Jongseol LEE was nominated as the Chair of WGD RR by the WGD RR members as he takes the post as the Director General of NDMI in 3 December, 2021.
- 84. The Working Group expressed their sincere appreciation to the Chair Dr. Sang Kwon LEE and the Vice Chairs Mr. Marcus AYDLETT and Dr Yuntae KIM for their contribution and effort in the past years.
- 85. Members from China, Hong Kong China, Laos PDR, NDMI Korea, USA and Vietnam presented their report during the parallel meeting.

86. The Working Group passed the following AOPs for 2022:

- a) AOP1. Capacity Building / Knowledge Sharing (NDMI)
 - Initially a seminar regarding capacity building was proposed to be held in Palau in August 2021. Due to the outbreak of COVID-19 around the world, NDMI decided to postpone the seminar to 2022.
- b) AOP2. Setting up Early Warning and Alert System (NDMI)
 - Since 2013 NDMI has launched the project for strengthening capabilities of disaster risk reduction with various countries. A similar project in Lao PDR was implemented in 2021. Feasibility studies such as site visit, land survey and meetings with local offices were conducted with a plan to install early warning and alert systems in Houaphanh and Xaisomboun Province in 2022.
- c) AOP3. WGDRR Annual Meeting
 - Owing to the COVID-19 pandemic situation, WGDRR annual meeting has been using online platforms since 2020. If the situation in 2022 permits, it will allow for a face to face meeting in Korea. If not, it will still be an online meeting.
- d) AOP4. Benefit Evaluation of Typhoon DRR (STI)
 - The project named "Benefit evaluation of typhoon disaster prevention and preparedness" aims to promote the research relating to this topic. Recent work focused on development and improvement of more specific levels in a region on risk assessment technique and the potential risk assessment model's resolution.
 - STI will continue to work on the research of Benefit Evaluation of Typhoon DRR which was funded by STI. However, as the COVID-19 pandemic situation continues, some visiting foreign scientists are restricted from travelling to Mainland China for fellowship research. If the situation allows, the fellowship program will resume again and STI will help with funding.
- e) AOP5. Sharing Information related to DRR (NDMI)
 - WGDRR will continue to exchange information and experience related to DRR through the forum on the TC website. Members are welcome to upload any DRR information such as data, video clips to the TC website.
- f) AOP6. Making Education Videos related to DRR (HKO)
 - HKO will help to produce more education videos related to DRR and the budget for 2022 will be USD\$2,000.
- g) AOP7. Seminar for TC Crowd-sourcing high density non-conventional weather data (HKO)
 - HKO proposed to arrange an online seminar in lieu of the face-to-face seminar. The online seminar will be comprised of two sessions on sharing the concept and experience of developing "My Weather Observation" and "Micro-climate Weather Station" by HKO. The members agreed with HKO's proposal.

Conclusions of WGDRR

87. On the basis of the information provided by the Members, the reports presented by project coordinator/leader and findings of the parallel session on WGDRR, the following conclusions were reached:

- a) Dr. Jongseol LEE will serve as the Chair of WGDRR as he was assigned to be the Director General of NDMI to replace the former Chair, Dr. Sang Kwon LEE on 3 December, 2021.
- b) With the continuous travel restrictions and risk of infection from COVID-19, most of the projects could not be carried out as planned. However, projects such as the

educational video, DRR meeting and DRR information sharing were successfully implemented.

- c) The 16th WGDRR annual workshop was unable to be held physically in Republic of Korea due to COVID-19 pandemic. Instead of the face-to-face workshop, a video meeting hosted by NDMI Korea was held on 5 November 2021 to discuss the issues related to WGDRR activities. The WG reviewed the 2021 AOP implementation with the budget expenditure and proposed the plans for 2022. Besides the TC DRR members, ADRC, WMO and ESCAP were also invited to join the meeting to give informative and valuable comment for WG.
- d) WGDRR decided to continue conducting the projects which can improve capacities of disaster management among TC Members through the project of information exchange and sharing such as participation in the important DRR world conferences, organizing the expert team to selected member states and using effective platform to exchange DRR information, as well as holding the WGDRR annual meeting.
- e) WGDRR decided to continue the projects related to public education on DRR for promotion in the coming future which can raising public awareness on typhoon related disasters.
- f) At the WGDRR annual meeting, HKO expressed that they can continue providing videos especially related to tropical cyclone or severe weather for TC DRR public education use. The project will be led by HKO.
- g) HKO proposed to arrange online seminar in lieu of the face-to-face seminar. The online seminar will be comprised of two sessions on sharing the concept and experience of developing "My Weather Observation" and "Micro-climate Weather Station" by HKO. The members agreed with HKO's proposal.
- h) The project of Capacity Building/Knowledge Sharing in DRR. Due to the travel restrictions by the pandemic, it has been cancelled for implementation in 2021 and WGDRR decided to postpone the project until 2022 subject to the situation related to travel restriction and situation of the pandemic.
- i) For implementation of the proposed projects in 2022, WGDRR proposed the request of USD \$12,000 to be allocated by the TCTF for the following items:
 - To allocate USD \$10,000 budget of TCTF in 2022 for Capacity Building/Knowledge Sharing in DRR
 - To allocate USD \$2,000 budget of TCTF in 2022 for Making Education Video related to DRR
- j) Discussion of the Priorities for WGDRR draft of the Strategic Plan 2022-2026. Members agreed the following priorities and corresponding KRAs.

WG	Priorities	Key Result Area KRA						
		1	2	3	4	5	6	7
DRR	Provide reliable statistics of mortality and direct disaster economic loss caused by typhoon-related disasters for monitoring and the targets of the Typhoon Committee	X					X	
	Enhance Members' disaster risk reduction techniques and management strategies			X	X	X		X
	Evaluate socio-economic benefits of disaster risk reduction for typhoon-related disasters		X	X	X	X		
	Promote international cooperation of DRR implementation project		X	X	X	X		X
	Share experience/know how of DRR activities including legal and policy framework, community-based DRR activities, methodology to collect disaster-related information.	X			X	X		X

Recommendations of WGDRR

88. On the basis of the conclusion, the WGDRR made the following recommendations:
- a) To request NDMI to organize a team of selected member for the project of capacity building and knowledge sharing in DRR.
 - b) To request NDMI to continue supporting the development and improvement of the early warning and alert systems related to typhoon disaster in the participating members.
 - c) To request NDMI, Republic of Korea to continue supporting and hosting the WGDRR Annual Workshop in 2022 in ROK.
 - d) To request STI, China to continue conducting research for the project benefiting evaluation of typhoon disaster prevention and preparedness.
 - e) To encourage Members to share information related to DRR on the established forum of TC Website.
 - f) To request HKO to continue providing WGDRR with a video related to typhoon disaster or severe weather and translate it into English version (voiceover and subtitle) for Members use on DRR public education.
 - g) To request HKO to conduct a seminar for TC crowd-sourcing high density non-conventional weather data
 - h) To request the TC to approve the proposed projects and related budget in 2022.
 - i) To approve Dr. Woojung CHOI as Vice Chair, in replacement of Dr. Yuntae KIM who retired from the role of Vice chair on 14 January, 2022.

8.4. Training and Research Coordination Group (TRCG)

89. The Committee took note of the progress made in training and research activities as presented in the TRCG Report 2021 (**Appendix XIII**)
90. The Committee recognized that the RSMC Tokyo Training Attachments were successively held on 9-11 March 2021 and 11-13 January 2022 with a total of nearly 100 forecasters from TC Members participating in the two Attachments. The Committee thanked Japan and WMO TCP for continuous support in this capacity-building initiative.
91. The Committee noted the successful completion of the Sixth International Distance Training Course on Tropical Cyclone Monitoring and Forecasting hosted by CMA and conducted online from 25 November to 3 December 2021; and appreciated China on organizing this Typhoon Forecaster Training Programme for 64 local trainees and 133 forecasters from 30 NMHSs including TC and PTC Members.
92. The Committee thanked Hong Kong, China for hosting research fellowship projects in 2021/2022.
93. The Committee was informed about the proposed plan of the 4th TRCG Forum and TRCG Planning Meeting to be held in Q4 of 2022 in conjunction with the 17th IWS. In view of COVID-19 pandemic situation, the Roving Seminar would be further postponed to Q2 of 2023 and would be hosted by Viet Nam.

94. The Committee thanked TRCG's contribution to develop a proposal on a time-bound Pilot Project to be pursued under the collaborative agreement between the Committee and the Asia-Pacific Typhoon Collaborative Research Center (AP-TCRC).
95. The Committee appreciated TRCG's inputs in support of training and research activities in connection with TC's cross-cutting projects.

Recommendations of TRCG:

96. On the basis of the conclusions reached by the deliberation of Members, the TRCG made the following recommendations:
 - a) To request Members to confirm their respective focal points as members of TRCG and update the list of resource persons as appropriate.
 - b) To endorse the priority training and research areas as proposed in TRCG Annual Report 2021.
 - c) To endorse the TRCG Work Plan for 2022-2023 and AOP 2022 (with Q1 of 2023) including the hosting of the 4th TRCG Forum and the TRCG Planning Meeting under the support of TCTF, and other budget requests which are incorporated into the budget proposal to be submitted by AWG.

IX. REPORTS OF THE TCS AND AWG (agenda item 9)

9.1 Activities of TCS

97. The Committee took note of the report of the Typhoon Committee Secretariat and further recommendations submitted by TCS. (**Appendix XIV**)
98. The Committee noted with appreciation the TCS's activities in 2021 which helped to enhance coordination and support to Members and coordinate WG activities during the ongoing COVID-19 pandemic situation.
99. The Committee noted with high appreciation the Macao Government for the strong support to TCS in the past years.
100. The Committee expressed appreciation to Members for their donation for the Typhoon Committee Trust Fund and in-kind contributions and encouraged Members to continue support activities of the Committee.

9.2 Activities of AWG

101. The Committee was informed of the activities and major issues discussed at the AWG Meetings in 2021 and prior to the 54th Session of the Typhoon Committee (**Appendix XV**).
102. The Committee was informed of the proposed budget for 2022/2023, including the items in support of non-recurring items for special funding consideration.

Recommendations of AWG

103. The AWG made the following recommendations:

- a) Recognize and thanked Japan for their leadership and great effort in hosting the 53rd Session of the Typhoon Committee virtually in February 2021.
- b) Recognize and thanked ESCAP for their exceptional effort in hosting the 16th IWS virtually in December 2021.
- c) Take note of the postponement of the 4th TRCG Forum due to the COVID-19 pandemic.
- d) Appreciate the contribution of Mr. TANAKA Nobuyuki to the AWG in the past years and endorse Mr. HOSOMI Takuya, Head of RSMC Tokyo, as the new co-Vice Chair of the AWG.
- e) Take note of the progress and recommendations made in the planning and implementation of TC activities, including review of the expenditure of Working Groups and the preparation of the budget for 2022/2023.

X. STRATEGIC PLAN 2022-2026 (agenda item 10)

- 104. The Committee was informed of the proposal and amendments for the new Strategic Plan 2022-2026 as discussed during the Typhoon Committee 16th IWS. (**Appendix XVI**)
- 105. The Committee was informed of the proposed revisions to KRA 7 which was received after the 16th IWS.
- 106. The Committee was informed of the proposed revisions to the Priorities and KRA tables as submitted by the Chairpersons of the Working Groups.
- 107. The Committee expressed its appreciation to the leadership of Mr. Raymond TANABE from the USA and the drafting team on the conclusion on the Strategic Plan 2022-2026.

XI. REPORT ON DRAFT AGREEMENT AND TIME-BOUND PILOT PROJECT ON THE ASIA PACIFIC TYPHOON COLLABORATIVE RESEARCH CENTER (AP-TCRC) (agenda item 11)

- 108. The Committee was informed of the progress of the Joint Task Team (JTT) in drafting the Agreement and the Time-bound Pilot Project on technical cooperation between the Typhoon Committee (TC) and the Asia-Pacific Typhoon Collaborative Research Center (AP-TCRC).
- 109. The Committee reviewed and discussed the draft Agreement and the Time-bound Pilot Project on technical cooperation between the TC and AP-TCRC in Annex A and Annex B, respectively. (**Appendix XVII**)
- 110. The Committee was informed of AWG's discussion on whether the term "Agreement" or "MoU (Memorandum of Understanding)" should be used in the title of the document, as shown in Annex to **Appendix XV** in TC54 report. Considering that the idea of non-legally binding has been clearly stated in relevant Articles of the document, the Committee agreed that the title of the document does not affect its legal status, and this "Agreement" document is not legally different in nature from (not legally above/below) a MoU. The Committee agreed to accept the use of "Agreement".
- 111. The Committee endorsed the Agreement and the Time-bound Pilot Project on technical cooperation between the TC and AP-TCRC. The Committee approved and agreed that the TC Chair delegates the TC Secretary to sign the Agreement on behalf of the Typhoon

Committee. The Committee also requested TCS to arrange the logistics arrangements on the signing of the document in due course.

Recommendations of JTT

112. On the basis of the deep discussion and communication, the JTT made the following recommendations :
- a) Recognize and thank the effort of the JTT in drafting the Agreement and the Time-bound Pilot Project on technical cooperation between TC and AP-TCRC.
 - b) Appreciate the valuable comments and inputs of TC Members and AWG Members in refining the draft documents.
 - c) Endorse the draft Agreement on Technical Cooperation and Research Activities between TC and AP-TCRC.
 - d) Endorse the draft Time-bound Pilot Project of the Technical Cooperation and Research Activities between TC and AP-TCRC.

XII. HOSTING OF TCS (agenda item 12)

113. The Committee took note of the information on the issue for hosting next TCS from 2023 to 2026. **(Appendix XVIII)**
114. The Committee expressed highly appreciation to the Government of the Macao Special Administrative Region of the People's Republic of China, and the Macao Meteorological and Geophysical Bureau for hosting and continued supporting TCS.
115. The Committee accepted the kind offer from Macao, China to host TCS for another four-year period from 2023 to 2026.

XIII. PUBLICATIONS (agenda item 13)

116. The Committee took note of the publications of the Typhoon Committee in 2021. **(Appendix XIX)**
117. The Committee noted with appreciation all Members' contributions to the publications of Typhoon Committee which have promoted the visibilities and transparencies of TC. The Committee further urged Members to take measures and actions for continuing support the TC publication and making contributions to the TCRR Journal especially.

XIV. PROGRAMME FOR 2021 AND BEYOND (agenda item 14)

14.1. Replacement of tropical cyclone names (Appendix XX)

118. The Committee noted Macao, China provided PEILOU, PATUA and PAOCHOK as replacement names for LINFA; and CHOILONG, LONGYAMEN and PENHA as replacement names for VONGFONG. The Committee decided to accept PEILOU and PENHA as replacement of LINFA and VONGFONG, respectively.
119. The Committee noted the Philippines provided NARRA and KUSOG and GITING as replacement names for MOLAVE and decided to accept NARRA.
120. The Committee noted the Republic of Korea provided GAENARI, SORA and GARION as replacement names for GONI and decided to accept GAENARI.
121. The Committee noted Viet Nam provided BANG-LANG, HOA-SIM and LUC-BINH as replacement names for VAMCO and decided to accept BANG-LANG.

XV. COORDINATION WITH OTHER ACTIVITIES OF THE WMO TROPICAL CYCLONE PROGRAMME (agenda item15)

122. The Committee was presented with activities under, and those requiring coordination through, the WMO Tropical Cyclone Programme (TCP). It appreciated the comprehensive presentation, and thanked WMO's support to the Committee. **(Appendix XXI)**
123. The Committee was informed that the Extraordinary session of WMO Congress 2021 (Cg-Ext-2021) (October 2021, online) approved 12 resolutions that are critical for long-term development of WMO. Among them, three will have critical support for better implementation and long-term development of TCP. They are:
 - Resolution 1/ (Cg-Ext 2021) - WMO Unified Policy for the International Exchange of Earth System Data, which enables coverage of Earth system data exchanged among Members.
 - Resolution 8/ (Cg-Ext 2021) - Comprehensive review of the WMO regional concept and approaches, which enables regional structure and governance to fit most regional diversity and characteristics, and to meet evolving regional and national requirements.
 - Resolution 10/ (Cg-Ext 2021) - Towards a structured WMO response to global crises, which requires a review of principles and approaches related to Members' business continuity and contingency planning to maintain their essential operations.
124. The Committee was informed that Executive Council (EC-73, June 2021) approved a recommendation to introduce additional categories of subsidiary bodies of Technical Commissions to better address needs related to consultation and coordination (Advisory Group). As per recommendation of the Standing Committee on DRR and Public Services (SC-DRR), the president of the Technical Commission for Services (SERCOM) had approved the establishment of the Advisory Group on Tropical Cyclones (AG-TC). The Advisory Group will mainly be responsible for coordinated developments of globally applicable techniques and practices in tropical cyclone forecasting and warnings services.
125. In this connection, the Committee was informed that the kick-off meeting of the AG-TC was held online in early February 2022 with one of the agenda items focusing on development of impact-based tropical cyclone forecast products – to continue to implement the Decision 10/EC-68 (2016).

126. The Committee was informed of progress on implementation of Resolution 16 and resolution 14 of WMO Cg-18, supported by ET-MTG and ET-WCM respectively. The ET-MTG is to address the Resolution 16 (Cg-18) with the development of a guide for the effective support by NMHSs to their national disaster risk management and response. This guide is focusing on tropical cyclones as a first step. A draft guide will be submitted to SERCOM by October 2022 for approval.
127. The Committee was informed that under the overall framework on WMO IBF guideline WMO TCP is promoting tropical cyclone IBF information/products for regional tropical cyclone forecasting advisories and national tropical cyclone forecasting information and warnings to people.
128. The Committee noted with appreciation that many training activities on tropical cyclones were organized during the past year to support capacity development of the Members to meet competency and skills that are required for tropical cyclone forecasting and services.
129. The Committee was informed that the regional activities on tropical cyclone regional bodies were well organized in the past year. Those meetings updated regional arrangements for tropical cyclone circumstances, and strengthened regional collaboration and coordination with concerted approaches toward tropical cyclones.
130. The Committee was informed that the 10th International Workshop on Tropical Cyclones (IWTC-X) is planned to take place in Shanghai, China, tentatively from 5-9 December 2022. This is a quadrennial event jointly organized by WGTMR/WWRP and TCP.
131. The Committee was informed of the publication of the Review of the 40 Years of WMO Tropical Cyclone Programme (in E-Library) which will be downloadable after release, and The Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes (1970–2019). The Review briefly described essential businesses, major progresses, working mechanism, and some good lessons and practices in all aspects in the history of TCP, suggested way forward. This will be a good reference in understanding TCP. For information on loss and deaths by tropical cyclone for the past 40 years, the Atlas shall be able to serve as good and authoritative source of information.
132. The Committee was informed that the pilot project on Tropical Cyclone-Probabilistic Forecast Products (TC-PFP) was going well. A workshop involving RSMCs and TCWCs was organized on 15, 17-18 June 2021. The workshop was held online and attended by 80-100 participants from research communities as well as operational centres. The outcomes of the workshop will serve as input to the IWTC-X meeting in 2022, providing guidance on best practices for probabilistic TC forecasting.
133. The Committee was informed that WGTMR would organize the three projects (EXOTICCA, TLFDP and UPGRAFT) meeting in early March 2022 with expected projects outcomes and recommendations to move forward. The Committee Members are encouraged to share and exchange data, conventional and nonconventional, to improve tropical cyclone forecasting and warning services. WMO Secretariat will support to coordinate the sharing and exchange of the data.
134. The Committee was informed that all activities in relation to TCP under WMO Annual Operating Plan were very well implemented without delay. There was no impact by

COVID-19 pandemic while implementing TCP activities. The Committee expressed sincere appreciation to WMO Secretariat and Members to have made all possible efforts to work closely to enable to carry out TCP activities with success.

XVI. SUPPORT REQUIRED FOR THE COMMITTEE'S PROGRAMME (agenda item 16)

16.1. Typhoon Committee Trust Fund (TCTF)

135. The Committee reviewed the provisional statement of account of TCTF for the period of 1 January to 31 December 2021 as in the Appendix B and the final statement for 1 January to 31 December 2020 as in **Appendix XXII**, submitted by the representative of the WMO Secretariat. The statement for 2020 had gone through auditing by WMO external auditors. The auditing report for 2020 statement had been communicated to TCS. The Committee expressed appreciation to the WMO Secretariat for its good management of the TCTF.
136. The Committee encouraged its Members to continue and possibly enhance Members' contribution to the Fund, although on voluntarily basis, for the purpose of sustainable support for activities of the Committee.
137. The Committee was informed by TCS, the summary of income and expenditure from 1 January to 31 December 2019 and 2020 and the provisional summary of income and expenditure for 2021 related to the execution of the Work Plan 2019, 2020 and 2021. In addition, provisional summary of income and expenditure from 1 January to 31 March 2022 and summary of TCTF budget 2019/2020, 2020/2021 and 2021/2022 with additional three months from January to March 2020 to 2022 was provided as reference. (**Appendix XXIII**)

16.2. In-kind Contributions

138. The Committee expressed appreciation for the in-kind contributions from some Members, namely China; Hong Kong, China; Japan; the Philippines; Republic of Korea; Thailand and USA. The Committee also invited other Members to report their in-kind contributions, quantifying the corresponding unit of Man-months that have consumed in actions related to TCTF projects. (**Appendix XXIV**).
139. The Committee also expressed the importance of having in-kind contributions with correspondence values.

16.3. Approval of Typhoon Committee Trust Fund (TCTF) 2022/2023 Budget

140. The Committee took note that the allocation from normal and special budget by WG's has been approved by Chair of Typhoon Committee and Secretary of Typhoon Committee.
141. The Committee discussed and approved the budget proposal for 2022/2023. (**Appendix XXV**)

XVII. DATE AND PLACE OF THE 17TH IWS (agenda 17)

142. The Committee took note, and by following the updated sequential list table of Annual Sessions and IWS, that the 17th IWS will be held in ESCAP conference facilities in Q4 2022. The final date and arrangements will be confirmed in due course by TCS and ESCAP.
143. As the pandemic situation is still unclear, the Committee requested TCS to communicate with the TC Chair, AWG and ESCAP, if the 17th IWS will be held face-to-face or online format.

XVIII. DATE AND PLACE OF THE 55th SESSION (agenda 18)

144. The Committee was informed that Macao, China would host the 55th Session in Macao, China. The tentative dates would be middle/late February in 2023. The final arrangements will be confirmed by Macao, China and later communicated to TCS.

XIX. HOSTING OF THE 18TH IWS AND 56TH TC SESSION (agenda 18)

145. The Committee took note, and by following the updated sequential list table of Annual Sessions and IWS, that the Cambodia, the next host for the 18th IWS in 2023, is unable to host the IWS and requested the AWG to discuss hosting arrangements of the 18th IWS in the next AWG Meeting.
146. The Committee was informed that Malaysia is willing to host the 56th Session of Typhoon Committee in 2024. The final date and place will be confirmed in due course by Malaysia and later communicated to TCS.

XX. OTHER BUSINESS (agenda 19)

147. The Committee noted the presentation given by the USA on Data Sharing and Dvorak Analysis and requested WGM to consider including this data sharing under a meteorological data sharing project.
148. Noting that the Committee is an intergovernmental body, the Committee requested ESCAP and TCS to continue to communicate with Members through their diplomatic channels and through their WMO Permanent Representatives, for Members to designate their delegations to a TC Session.

XXI. CLOSURE OF THE VC SESSION (agenda 20)

149. The delegates from the Members of the Typhoon Committee expressed their thanks and appreciation to Lao PDR, TCS and HKO for their supports in successfully hosting and

organizing the VC of the 54th Session of the Typhoon Committee in this unprecedented time.

150. The Chairperson of TC54 delivered the closing remark for the TC54 VC.
151. The VC Session was closed by the Chairperson at 12:03 pm, 25 February 2022 (Hong Kong Time).