



51st ESCAP/WMO TYPHOON COMMITTEE Session Report

Guangzhou • China
26 February - 01 March 2019



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**REPORT OF THE FIFTH-FIRST SESSION
OF TYPHOON COMMITTEE**

**Guangzhou, China
26 February – 01 March 2019**

PART I – DECISIONS OF THE COMMITTEE

1. The Committee decided to:
 - a. Approve Mr. YU Yong, Deputy Administrator of China Meteorological Administration (CMA), as Chairperson; Mr. SHUN Chi-ming, Director of the Hong Kong Observatory (HKO) as Vice-Chairperson and Mr. Raymond TANABE, Director, Pacific Region of National Oceanic and Atmospheric Administration (NOAA), National Weather Service (NWS), as Chairperson of the Drafting Committee.
 - b. Approve the recommendations submitted by Credential Committee as provided in the Appendix III.
 - c. Approve the recommendations from Advisory Working Group (AWG) submitted on the Overviews of Member's Report as expressed in paragraph 35.
 - d. Approve the Typhoon Committee Operational Manual (TOM) with the amendments provided in the Appendix XIII.
 - e. Approve the recommendations submitted by Working Group on Meteorology (WGM) as expressed in paragraph 57.
 - f. Approve the recommendations submitted by Working Group on Hydrology (WGH) as expressed in paragraph 97.
 - g. Approve the recommendations submitted by Working Group on Disaster Risk Reduction (WGDRR) as expressed in paragraph 85.
 - h. Approve the recommendations submitted by Training and Research Coordination Group (TRCG) as expressed in paragraph 93.
 - i. Request TCS and AWG to develop a final proposal to include the procedures for the new Membership for the approval at the 52nd Session.
 - j. Approve the reappointment of Mr. YU Jixin as the Typhoon Committee Secretary from 2019/2022 early 2023.
 - k. Approve KOINU, YAMANeko and YUN-YEUNG as replacement names for TEMBIN, HATO and KAI-TAK, respectively, in the list of the names of tropical cyclones.
 - l. Approve retirement of the names of tropical cyclones MANGKHUT and RUMBIA, respectively and request TCS to issue letters to relevant Members (Thailand and Malaysia) to provide replacement names in accordance with the Committee's procedure.

- m. Request TCS to invite interested Members to explore the feasibility of developing a coordination mechanism, with the support from their air traffic authorities, to facilitate the operation of reconnaissance flights into tropical cyclones across multiple Flight Information Regions (FIRs) and sharing of the resulting meteorological data.
- n. Approve the recommendations expressed on paragraph 130 on the updated of Accounting issues with WMO and TC.
- o. Approve the 2019/2020 Budget as presented below (see Appendix XXVII for detail):

By Group	2019/2020
	Proposed
TCS	34,000.00
ALL WGS (IWS ONLY)	73,000.00
TRCG	26,000.00
WGM	36,500.00
WGH	25,000.00
WGDRR	13,500.00
TOTAL	208,000.00
Plus	
Special Request Budget for WGs	28,000.00
Total	28,000.00
Total Proposed Budget plus Special Request Budget in 2019/2020	236,000.00

- p. Accept the kind offer of United States of America (USA) to host the 14th IWS in Guam. The proposed dates are 04-07 November 2019 and will be confirmed in due course by TCS.
- q. Accept the kind offer of Viet Nam to host the 15th IWS in 2020. The final date and place will be confirmed in due course by Viet Nam and later communicated to TCS.
- r. Accept the kind offer of Hong Kong, China to host the 52nd Session. The proposed dates are tentatively late February 2020 and will be confirmed in due course by TCS.
- s. Accept the kind consideration of Japan to host the 53rd Session in 2021. The final date and place will be confirmed in due course by Japan and later communicated to TCS.

PART II – PROCEEDINGS OF THE COMMITTEE

I. ORGANIZATION OF THE SESSION

2. The Fifty-First Session of the ESCAP/WMO Typhoon Committee (TC) was held at the Guangzhou, Dong Fang Hotel, China, from 26 February to 01 March 2019.

The Session was attended by **109** participants from 12 of 14 Members of the Typhoon Committee, namely: Cambodia; China; Hong Kong, China; Japan; Lao People's Democratic Republic (Lao PDR); Macao, China; Malaysia; Philippines; Republic of Korea; 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 Session.

The Session was attended by observers from Indonesian Agency for Meteorology, Climatology and Geophysics (BMKG), Asian Disaster Preparedness Center (ADPC), Asia Disaster Risk Reduction (ADRC), International Federation of Red Cross and Red Crescent Societies (IFRC), International Centre for Water Hazard and Risk Management (ICCHARM) and University of the Ryukyus of Japan. **Appendix I**

Opening of the Session (agenda item 1)

3. The opening ceremony of the Session began at 09:05 am on Tuesday, 26 February 2019. Mr. ZHOU Heng from CMA, China conducted the opening ceremony.
4. The following speeches were delivered at the opening ceremony and are provided in **Appendix II:**
 - a) **Mr. YU Yong**, Deputy Administrator of CMA, provided welcoming remarks and declare the Session Opened.
 - b) **Mr. YE Zhenqin**, Member of the Standing Committee of the CPC Guangdong Committee.
 - c) **Prof. Petteri TAALAS**, Secretary-General, World Meteorological Organization.
 - d) **Mr. Sanjay SRIVASTAVA**, Chief, Information and Communications Technology, Disaster Risk Reduction, United Nations Economic and Social Commission for Asia and the Pacific
 - e) **Prof. Tran Hong THAI**, Acting Administrator Viet Nam Meteorological and Hydrological Administration, on behalf of TC Chairperson.
 - f) **Mr. YU Jixin**, Secretary of the Typhoon Committee.
5. Dr. Roman L. KINTANAR Award for typhoon related disaster mitigation was presented to: Guangdong Meteorological Service of CMA, China, in recognition of their outstanding contribution towards tropical cyclone forecasting and excellent weather service for natural disaster prevention and damage mitigation in 2018.

II. REPORT ON CREDENTIAL COMMITTEE (agenda item 2)

6. Dr. LEI Xiaotu, Chair of WGM, Mr. Yoshio TOKUNAGA, Chair of WGH, as appointed members of the Credential Committee, reviewed the Credential Letters submitted by TC Members. Mr. Yoshio TOKUNAGA, who was appointed as Chair of the Credential Committee at the 50th Session, presented the Summary Report of the Credential Committee which can be consulted at Appendix III.

III. ELECTION OF OFFICERS (agenda item 3)

7. Mr. YU Yong, Deputy Administrator of CMA, was elected Chairperson and Mr. SHUN Chi-ming, Director of the HKO was elected Vice-Chairperson of the Committee.
8. Mr. Raymond TANABE, Director, Pacific Region of NOAA, NWS, was elected Chairperson of the Drafting Committee.
9. The appointment of the Chair of the Credential Committee will be on rotation basis within the 3 Chairs of the WGs. Therefore, the WGD RR Chair, has been appointed to serve as Chair of the Credential Committee for the 52nd Session.

IV. ADOPTION OF THE AGENDA (agenda item 4)

10. The Committee adopted the agenda as shown in Appendix IV.

V. KEYNOTE SESSION (agenda item 5)

11. The Keynote Session started with the presentation of WMO Secretary General on the title "WMO 2030" and followed by the presentations from Ms. WANG Jianjie, China, Mr. SHUN Chi-ming, Hong Kong, China and Mr. Yasuo SEKITA, Japan related to the theme of the next 50 years. The presentations can be found in Appendix V.

VI. TECHNICAL PRESENTATIONS (agenda item 6)

6.1 Summary of the 2018 typhoon season

12. The Committee noted with appreciation the review of the 2018 typhoon season provided by the RSMC Tokyo as provided in Appendix VI whose summary is presented in paragraph 12 – 23.
13. In the western North Pacific and the South China Sea, 29 named tropical cyclones (TCs) formed in 2018, which was above the 30-year average, and 13 out of them reached typhoon (TY) intensity, whose ratio was smaller than the 30-year average.
14. Eighteen named TCs formed in summer (June to August), which ties with 1994 as the largest number of formation in summer since 1951. Among them, nine named TCs formed in August, which is the third largest number of formation in August after ten in 1960 and 1966. During the month, sea surface temperatures were above normal in the tropical Pacific east of 150°E.

Enhanced cyclonic vorticity existed over the sea east of the Philippines where strong south-westerly winds due to the above-normal monsoon activity and easterly winds in the southern side of the Pacific High converged. Adding to these, upper cold lows cut off from the meandering subtropical jet stream in the central to eastern North Pacific repeatedly moved southward and westward. These factors are thought to have contributed to the large number of TC formation.

15. The number of TCs whose maximum sustained winds reached 105 kt (violent TY) was seven, which is the largest number on record since 1977. These TCs moved over the area where ocean and atmospheric conditions were favourable for the intensification of TCs, such as warm sea surface temperatures and weak vertical wind shear.
16. The mean genesis point of named TCs was 16.3°N and 137.2°E, which was almost the same as that of the 30-year average. The mean genesis point of named TCs formed in summer (June to August) was 19.5°N and 137.8°E, with almost no deviation from that of the 30-year summer average, and that of named TCs formed in autumn (September to November) was 12.3°N and 138.4°E, showing a south-southeastward deviation from that of the 30-year autumn average. The autumn deviation could be partly attributed to below-normal SSTs around the Philippines, above-normal SSTs in the tropical Pacific east of 150°E and associated convection anomalies.
17. The mean duration of TCs sustaining TS intensity or higher was 5.2 days, almost the same as that of the 30-year average (5.3 days). The mean duration of TCs sustaining TS intensity or higher formed in summer was 5.0 days, almost the same as that of the 30-year average (5.1 days), and the mean duration of TCs sustaining TS intensity or higher formed in autumn was 6.4 days, longer than that of the 30-year average (5.6 days). The longer duration in autumn is consistent with anomalies observed in the past El Nino events.
18. Three named TCs formed from January to March. Bolaven (1801) formed as TS over the South China Sea and Sanba (1802) formed to the east of the Palau Islands. These two TCs caused damage in the Philippines.
19. Four named TCs formed in June. Ewiniar (1804) formed around Hainan Island and caused damage in China, Hong Kong, China and Macao, China. Prapiroon (1807) formed around the sea south-southeast of Okinawa Island and affected the Republic of Korea.
20. Five named TCs formed in July. Maria (1808) formed over the sea around the Mariana Islands and caused damage in China. Son-tinh (1809) formed around the Luzon Strait and caused damage in China, Hong Kong, China and Macao, China, Viet Nam and Lao PDR. Ampil (1810) formed over the sea east of the Philippines and hit China. Jongdari (1812) formed to the east of the Philippines, took an unusual track due to the interaction with an upper cold vortex and eventually hit Japan and China.
21. Nine named TCs formed in August. Shanshan (1813) formed over the sea east of the Mariana Islands and hit Japan. Yagi (1814) formed around the sea east of the Philippines and hit China. Leepi (1815) formed over the sea west of the Mariana Islands and hit Japan. Bebinca (1816) formed over the South China Sea east of Hainan Island and caused severe damage to China; Hong Kong, China and Macao, China, Viet Nam and Lao PDR. Hector (1817) entered the western North Pacific with TS intensity on 13 August. Rumbia (1818) formed over the East China Sea and caused severe damage to China. It also affected the Republic of Korea and the Democratic People's Republic of Korea. Soulik (1819) formed over the sea to the northwest

of Guam Island and caused damage in the Republic of Korea and the Democratic People's Republic of Korea. Cimaron (1820) formed over the sea north of the Chuuk Islands and hit Japan. Jebi (1821) formed over the sea around the Marshall Islands and caused severe damage to Japan.

22. Four named TCs formed in September. Mangkhut (1822) formed over the sea around the Marshall Islands and caused severe damage to the Philippines, China, Hong Kong, China and Macao, China and Viet Nam, and affected Lao PDR and Thailand. Barijat (1823) formed over the South China Sea and hit China. Trami (1824) formed over the sea around the Mariana Islands and caused damage in Japan. Kong-rey (1825) formed over the sea to the southwest of Guam Island and caused damage in the Republic of Korea and the Democratic People's Republic of Korea.
23. Four named TCs formed in October and November 2018. Yutu (1826) formed over the sea around the Marshall Islands and caused severe damage to the Philippines. Toraji (1827) formed over the South China Sea and caused severe damage to Viet Nam. Usagi (1829) also formed over the South China Sea and caused damage in Viet Nam.

6.2 Verification of tropical cyclone operational forecast in 2018 typhoon season

24. The Committee took note with appreciation of the report on verification of tropical cyclone operational forecast in 2018 typhoon season provided by the Shanghai Typhoon Institute (STI) in Appendix VII presented by Mr CHEN Guomin, on behalf of Chairperson of WGM.
25. Using different best track data as reference may have a significant impact on the final verification results.
26. For official agencies, annual mean track errors at the lead time of 24, 48, 72, 96 and 120 h were already less than 95, 140, 190, 290 and 420 km in 2018.
27. For both official agencies and models, annual mean track errors were decreasing significantly for the last 10 years. However, maxima errors of forecast guidance were still 3 to 5 times larger than annual mean error in 2018.
28. Both global and regional models were usually under-estimated the TC intensity in 2018.

6.3 Updates on SSOP-II Project

29. The Committee took note of the updated report of the SSOP-II project presented in the report (Appendix VIII).

6.3.2 Other technical presentations

30. The technical lectures were presented as shown in Appendix IX. The Committee expressed its appreciation to all the lecturers and requested the TCS to post all the lecture papers/PowerPoint presentations on the TC website.

VII. REPORT ON TC'S KEY ACTIVITIES AND OVERVIEW SUMMARY OF MEMBERS' REPORTS (agenda item 7)

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

31. The Committee took note of the report of the Typhoon Committee Chairperson on the TC's Key Activities and Main Events in the Region, 2018, as showed in Appendix X.
32. The Committee expressed appreciation to the contributions of Dr. Le Cong THANH as the Chairperson of TC during 2018.
33. Viet Nam expressed its appreciation to WMO, ESCAP and International Organizations for the support during its term as Chairperson in 2018.

7.2 Overview Summary of Members' Reports

34. The Committee took note of the Summary of Members' Reports 2018 highlighting the key tropical cyclone impacts on Members in 2018 and the major activities undertaken by Members under the TC Priorities and components during the year (Appendix XI).
35. 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:

- a) AWG recommended the Committee to consider the key tropical cyclone impacts on Members in 2018 and review the initiatives and activities to be pursued in support of the 21 TC Priorities to mitigate future impacts.
- b) AWG recommended Members and Working Group Chairpersons to review the relative focus of activities in support of the TC 21 priorities and develop future activities to address those priorities which are under-served.

VIII. REVIEW OF THE ACTIVITIES OF RSMC TOKYO AND AMENDMENTS OF TOM (agenda item 8)

8.1 Review of the activities of the Regional Specialized Meteorological Center (RSMC) Tokyo 2018 (Appendix XII)

36. The Committee noted with appreciation the review of RSMC advisories, products and operational activities and changes made in 2018. It noted the forecast verification results for 29 TCs that reached TS intensity or higher formed in 2018: the forecast track errors of the year of 66 km (82 km in 2017), 112 km (151 km), 179 km (248 km), 277 km (335 km) and 409 km (420 km) for 24-, 48-, 72-, 96- and 120-hour forecasts, respectively, the annual mean RMSEs for central pressure forecasts of 13.8 hPa (10.1 hPa), 18.7 hPa (14.9 hPa) and 20.4 hPa (16.9 hPa) for 24-, 48- and 72-hour forecasts, respectively, and those for maximum wind speed forecasts for 24-, 48- and 72-hour forecasts of 5.4 m/s (5.0 m/s), 6.9 m/s (6.8 m/s) and 7.3 m/s (7.8 m/s), respectively.

37. The Committee noted with appreciation to the changes of RSMC advisories, products and operational/coordination activities in 2018. It also noted the planned changes, that is, the commencement of 5-day tropical cyclone intensity forecasts, revision of probability circle and enhanced communication service on a trial basis.
38. The Committee expressed its appreciation to the operation of RSMC Tokyo's Numerical Typhoon Prediction (NTP) website and noted changes made in 2018 and those planned in the near future.
39. The Committee expressed its appreciation to the continuous 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 at selected stations and multi-scenario storm surge predictions as well as week-range wave forecasts which will newly include probability forecasts on peak wave period in addition to significant wave heights in January 2019. The Committee encouraged Members to make their sea level observation available to contribute to the verification activity. It also noted with appreciation for RSMC Tokyo's intention to start provision of astronomical tides estimated by a global ocean tide solution (FES2014)¹ for 27 stations, where sea level observation data is not available, from 25 February 2019.
40. The Committee with appreciation noted the further development of RSMC Tokyo's Tropical Cyclone Activity Prediction maps using ensembles of ECMWF, NCEP, UKMO and JMA as well as a multi-center grand ensemble (MCGE) of them.
41. The Committee was pleased to note the progress of the regional radar network development project, whose experimental exchange of radar composite data among RSMC Tokyo, the Thai Meteorological Department (TMD) and the Malaysia Meteorological Department (MMD) started in 2016. The Committee expressed its appreciation to RSMC Tokyo for expanding this project by inviting three more Members, Lao P.D.R., the Philippines and Viet Nam, since 2018. It also noted with appreciation that a technical meeting for experts of the three Members and the new Members was held at the JMA headquarters in October 2018 to exchange information on experiences and challenges relating to regional radar data exchange and quality control, and to discuss future directions in the field.
42. The Committee was pleased to note the progress of the project on enhancing the utilization of Himawari-8/9 products, in which technical support for developing Rapidly Developing Cumulus Area (RDCA) identification using Himawari-8/9 data has been conducted. The committee noted with appreciation that a technical meeting was held with experts of MMD at the JMA headquarters in October 2018 to exchange information on recent progress and ideas for advanced products in the field.
43. The Committee noted that the final draft of the TC Forecast Competency was submitted and approved at the Committee's 50th annual session and accordingly the Typhoon Committee Operational Manual - Meteorological Components (TOM) including the Competency was submitted for approval at the Committee's 51st annual session.
44. The Committee noted with appreciation that RSMC Tokyo published the RSMC Tokyo Technical Review No.20 and the Annual Report on the Activities of the RSMC Tokyo Typhoon Center 2017 in March and December 2018, respectively.

¹ FES2014 was produced by NOVELTIS, LEGOS, CLS Space Oceanography Division and CNES. It is distributed by AVISO, with support from CNES (<http://www.aviso.altimetry.fr/>)

45. The Committee was informed that RSMC Tokyo started tropical cyclone satellite re-analysis in 2012 for the period from 1981 to confirm and improve the quality of the Current Intensity (CI) number in the satellite TC analysis. Re-analysis for the period from 1987 to 1999 and from 2004 to 2013 has been completed. RSMC Tokyo has been working on the re-analysis for the rest (2000 - 2003 and 2014 - present).
46. The Committee noted with appreciation the operation of Himawari-8/9 geostationary meteorological satellites and further welcomed the intention of RSMC Tokyo to continue providing Himawari products as well as technical support for using them.
47. The Committee was pleased to note that RSMC Tokyo conducted the 18th Attachment Training from 15 to 26 October 2018, inviting three forecasters from Macao (China), Malaysia and the Philippines. In accordance with the decision of the third joint session of the Panel on Tropical Cyclone (PTC) and the Typhoon Committee, RSMC Tokyo, ESCAP, WMO, and PTC secretariats invited two forecasters from PTC Members: Oman and Sri Lanka. The committee noted with appreciation to RSMC Tokyo's intention to accept a few more (including self-funded) trainees of Typhoon Committee.
48. The Committee noted the results of the annual observation exchange monitoring during the period of two typhoons in 2018: Soulik (1819) and Mangkhut (1822), which highlighted the special observation conducted by China, Hong Kong (China), the Republic of Korea and the Philippines during the periods. It expressed its appreciation to the four Members, who provided special observation data to the Committee Members, and further encouraged all the Members to conduct additional observation, as requested by the Typhoon Committee Operational Manual - Meteorological Components (TOM).

8.2 Typhoon Committee Operational Manual (TOM)

49. The Session noted that the Typhoon Committee Operational Manual (TOM) rapporteur requests WMO to publish and upload the 2019 edition of TOM on the Tropical Cyclone Programme (TCP) Website as submitted by the Rapporteur, with the amendments given in Appendix XIII.
50. The Committee expressed its appreciation to the rapporteur for update of TOM.

IX. REPORTS OF TC WORKING GROUPS AND TRCG (agenda item 9)

51. Parallel sessions of the Working Groups on Meteorology, Hydrology and Disaster Risk Reduction were convened during the 13th IWS to review progress of work during the past year, identify priorities for cooperation and make recommendations to the Committee.
52. The outcomes of the parallel sessions of the three Working Groups were reported to the plenary session as given in the following sections.

9.1. Meteorological Component

53. The Committee took note of the Member's activities and major progress and issues in Meteorological Component in 2018 as reported by Members at the 13th IWS.

54. 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 XIV.
55. The Committee took note of the outcomes of the WGM Parallel Session at the 13th IWS on 5-9 November 2018. With the assistances of TCP/WMO and TCS and the strong support from all Members, WGM has successfully completed the tasks in 2018 with significant outcomes as follows:
- a. WGM has fulfilled all the action plans (5 POPs, 6 AOPs and 2 PPs) in 2018, which were endorsed at the 50th Session.
 - b. After the 50th TC Session in 2018, WGM has been carrying out many activities that involve the cooperation among Members as well as other TC WGs and international organizations, which include:
 - i. Coordinated with the Shanghai Typhoon Institute (STI) to organize the first WGM Meeting in Shanghai on 9 July 2018.
 - ii. Coordinated with KMA for holding a technology transfer of Typhoon Operation System (TOS) from 8 to 12 October 2018. The Members involved are Lao PDR and Thailand.
 - iii. Coordinated with JMA for the RSMC Tokyo Attachment Training from 15 to 26 October 2018 with three forecasters from Macao, China; Malaysia and Philippines and two forecasters from Panel on Tropical Cyclones.
 - iv. Coordinated with JMA for holding a technical meeting on regional radar network from 22 to 26 October 2018 with participants from Lao PDR Malaysia, Thailand and Viet Nam.
 - v. Coordinated with JMA for holding a technical meeting on utilization of Himawari-8/9 products from 22 to 25 October 2018 with participants from Malaysia.
 - vi. Coordinated with CMA for the International Training Course on Typhoon Monitoring and Forecast from 10 to 19 December 2018.
 - vii. Coordinated with TRCG to host the 2018 research fellowships which include the following:
 - The National Typhoon Center (NTC) of KMA provided a training and research programme on Typhoon Operation System (TOS) and analysis of satellite and radar data from 23 April to 4 May 2018. Five participants from China, Malaysia, Philippines, Thailand and Viet Nam participated in the programme.
 - STI of CMA offered the fellowship on “Benefit Evaluation of Typhoon Disaster Prevention and Preparedness” to a forecaster from Malaysia from 2 May to 1 June 2018. The objective of the fellowship is introducing the techniques for evaluating the benefits of improving the accuracy of track and intensity forecast to improve the disaster prevention and preparation to the Members.
 - The Hong Kong Observatory (HKO) offered the fellowship on “Short-term Rainfall Forecast for Tropical Cyclone Using Himawari-8 Data and NWP Model Products” from 3 January to 1 March 2019. A forecaster from Viet Nam participated in the fellowship. The project aimed at developing rainfall estimate and short-term forecast products for tropical cyclones based on Himawari-8 data as well as forecasts from NWP models and ensemble prediction system.
 - The fellowship for the Visiting Editor for Tropical Cyclone Research and Review offered by STI will be conducted in February 2019.

CONCLUSIONS OF WGM

56. On the basis of the information provided by Members and the respective coordinator of the actions plan and based on the discussion during the 13th IWS, the following conclusions were reached:
- a. Members have made important progress in the implementation of the TC Strategic Plan during the year 2018.
 - b. Members made significant progress during 2018 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 2018.
 - d. Experts from other working groups of TC, WMO/TCP, TCS, RSMC-Tokyo, JTWC, etc. have also provided assistances to accomplish the tasks of WGM over 2018, namely the two WMO demonstration projects (TLFDP and TCEFP), visiting editor to TCRR editorial office (Shanghai) and research fellowships.
 - e. The 1st WGM meeting was held in Shanghai China on July 9, 2018 (Annex III of Appendix III). Major results of the meeting were reported during the WGM parallel session in the 13th IWS. WGM confirmed that it will maintain the existing chairperson with vice-chairpersons system (i.e., will not switch to co-chair), and proposed that Dr. Lei Xiaotu from China to continue to serve as chairperson in next two years. The vice-chairpersons will be Mr. Alui Bahari from Malaysia and Dr. Vicente B. Malano from the Philippines.
 - f. Based on the discussion on the action plans for 2019 during the 13th IWS, it was concluded to adopt the action plans as follows:
 - i. The POP item 1-5 and AOP item 1-6 will be continued in 2019.
 - ii. The PP2 item will be continued and moved to AOP7 in 2019.
 - iii. The PP1 item will be continued and moved to AOP8 in 2019.
 - iv. Establish 2 new PP item 1-2 in 2019.
 - g. The total budget proposed by WGM, which was concurred at the AWG meeting during the 13th IWS, for undertaking the actions plans (AOPs, POPs and PPs) in 2019 is US\$36,500. In addition, special budget of US\$15,000 will be allocated for publication of TCAR3 report, contribution for EXOTICCA-II and RaINS.
 - h. The complete WGM 2019 action plans (AOPs, POPs and PPs) including the actions, the success indicators, coordinators and budget are listed in Annex II of Appendix III.
 - i. Following the WGM report, China presented the proposal of the ESCAP/WMO Typhoon Committee Research Center, as requested by the post-AWG meeting of the 13th IWS.
 - j. The committee considered the proposal and recognized the necessity to further enhance research activities to cope with operational challenges and to develop the Committee Members' capacity.

RECOMMENDATIONS OF WGM

57. The WGM made the following recommendations:

- a) To reappoint Dr. LEI Xiaotu from China to continue to serve as chairperson in next two years and the vice-chairpersons Mr. Alui BAHARI from Malaysia and Dr. Vicente B. MALANO from the Philippines.
- b) To request KMA to continue provide seasonal typhoon outlook information for TC Members with further development in the techniques.
- c) To request CMA to encourage TC Members to nominate contact to join the Collaborative Discussion (CoDi) Forum and participate for trial during typhoon season.
- d) To request TCRR editorial office to hold the 3rd editorial committee meeting ad jointly with 14th IWS.
- e) To request KMA to continue provide technology transfer of the TOS for interested Members, and to provide technical support and new modules to existing Members already with the system.
- f) To request STI to continue the evaluation of performance of tropical cyclone forecast in western North Pacific in 2019, and to provide real-time verification in WMO-TLFDP website, and submit the post- verification report for 2019 season to 52th Session.
- g) To request JMA to further develop tropical cyclone genesis guidance using early Dvorak Analysis (EDA) and global ensemble.
- h) To request JMA to improve probability-circle radii in TC track forecasts using ensembles from multiple NWP centers and verify the new radii with tropical cyclone track data in 2019.
- i) To request CMA to continue improving the TRAMS (Tropical Region Atmospheric Model System) and provide forecast products to Members.
- j) To request JMA to further refine quality control techniques applied to MMD, TMD and VNMHA radar networks, and MMD and TMD's QPE calibration using rain-gauges.
- k) To request JMA to continue the experimental regional radar composite data exchange and share the progress with RA II/V WIGOS radar project in Southeast Asia for expansion of the experiment.
- l) To request JMA to hold follow-up technical meetings upon receipt of progress reports from TMD, MMD and VNMHA, and compose a user's guide among JMA, MMD and TMD.
- m) To request SMG to redistribute the survey form to acquire a more comprehensive survey result for evaluating the impacts of tropical cyclones in Typhoon Committee Region.
- n) To request SMG to organize the publication of the third assessment report by the end of 2019.
- o) To request JMA to provide astronomical tide estimated by global ocean tide solution to stations where astronomical tide is not available.
- p) To request JMA to add storm surge time series prediction upon request from Members.
- q) To request JMA to publish verification results of storm surge predictions.
- r) To request JMA to encourage Members to provide complete hourly tidal data of at least one year and sea level observations during storm surge events for improving the prediction and verification.
- s) To request JMA to commence a joint development with MMD for RDCA global coefficient with Himawari 8/9 products and to perform testing.

- t) To request JMA to host a meeting between JMA and MMD in late 2019 to exchange views and opinions on RDCA global coefficient.
- u) To request JMA to provide initial supports for development of RDCA by MSS and VNMHA.
- v) To request STI and HKO to continue field campaign, and to collect and share the field observation and research data, as possible, according to relevant data policies.
- w) To request STI and HKO to continue demonstration research on tropical cyclone intensity change in conjunction with WMO-TLFDP.
- x) To request CMA to evaluate the quality of surface observations, and to develop wind structure estimation based on available surface observations.
- y) To request MMD and HKO to integrate radar data, blend data with NWP data, and perform verification of RaINS/SWIRL.
- z) To request JMA to support AOP7 of WGH through providing knowledge on JMA's NWP model and instructions for the use of NWP products that are available via DIAS, and through sharing experiences on awareness raising to both local governments and public including the appropriate use of products.
- aa) To endorse the proposed action plans in 2019 (including 5 POPs, 8 AOPs and 2 PPs) as listed in Annex II of Appendix III – Summary Report for the WGM Parallel Meeting at the 13th IWS, which summarizes the above recommendations with additional action items.
- bb) To endorse the WGM budget request included in the budget proposal to be submitted by AWG for TC's approval.
- cc) To request AWG to work with relevant Members and WGs to prepare a more detailed proposal on a new joint research platform that was proposed by China and to submit it to the 52nd annual session for further consideration, especially paying attention to the comment to enhance research activities making the best use of existing mechanisms and functions to avoid duplication with other existing activities and functions.
- dd) To appoint Mr. Hisaki EITO as the rapporteur of TOM

8.2. Hydrological Component

- 58. The Committee reviewed the activities of the Members related to the implementation of the TC Strategic Plan and its annual operating plan (AOP) for the hydrological component during the past year. Details can be found in the Appendix XV.
- 59. The Session noted that, the water-related disaster events, including river flood, urban flood, flash flood and debris flow, and drought caused serious damage in some Members of the Committee in the past year, such as China, Laos, Japan, Republic of Korea, Malaysia, Philippines, Vietnam, etc. The hydrological departments in the Members provided valuable service of flood forecasting and warning to the decision-making departments of the Governments. The Members achieved remarkable progresses on capacity building of hydrological monitoring, data collection and flood forecasting and warning in 2018, particularly flood forecasting and warning system development in Malaysia and Philippines, Flash Flood Guidance (FFG) application in Vietnam, hydrological monitoring network construction in Laos.

60. The Session noted with pleasure that, the WGH 7th working meeting was successfully held from 9 to 11 October 2018 in Tokyo, Japan with theme of “Data Sharing for Flash Flood Risk Information”. About 30 participants from 9 Members namely China, Japan, Laos, Malaysia, Philippines, the Republic of Korea, Thailand, USA and Vietnam, and the hydrologist of TCS took part in the meeting. The Session expressed its appreciation to Japan Government through the Ministry of Land, Infrastructure Transport and Tourism (MLIT) with cooperation of International Center for Water Hazard and Risk Management (ICHARM) and Infrastructure Development Institute (IDI) for generously hosting the meeting. The Session also expressed its appreciation to China-side for funding one-day seminar on Decision Supporting to SOP for Coastal Multi-hazards Early Warning and Reduction in conjunction with WGH 7th working meeting on 12 October 2018.
61. The Session was informed with appreciation that the Republic of Korea (ROK) is willingness to host WGH 8th Working Meeting in October 2019.
62. The Committee was informed on the implementation status in 2018 and future activities of on-going projects (AOPs):
 - a. Flash Flood Risk Information for Local Resilience
 - b. Application of Hydrological Data Quality Control System in TC Members
 - c. Enhancement of Flood Forecasting Reliability with Radar Rainfall Data and Stochastic Technique
 - d. OSUFFIM Phase-II: Extension of OSUFFIM Application in TC Members
 - e. Impact Assessment of Climate Change on Water Resource Variability in TC Members
63. The Session noted that, MLIT and ICHARM of Japan conducted a series of activities for implementation of the project on Flash Flood Risk Information for Local Resilience in 2018, including sharing the concept and coordination of Platform on Water Resilience and Disasters, as an effort led by the International Flood Initiative (IFI). The Session also was informed that Japan will conduct a field research of IFI and compile case study of flash flood measures implemented in TC member in 2019 and beyond.
64. The Session noted that, 5 target Members, namely Republic of Korea, Lao P.D.R, Malaysia, Philippines and Thailand were selected for pilot study of the project led by ROK on Application of Hydrological Data Quality Control System in TC Members in 2018. ROK has completed the analysing the status of hydrological data monitoring and management in TC Members and surveying the Hydrological Data Quality Control System in ROK. The Session also was informed that the project will be conducted field survey, the design of hydrological data quality control system and technical report drafting in 2019.
65. The Session noted that, 4 target Members, namely ROK, Lao P.D.R, Philippines and Thailand, were selected for pilot study of the project led by ROK on Enhancement of Flood Forecasting Reliability with Radar Rainfall Data and Stochastic Technique in TC Members in 2018. ROK has completed the analysing the status of operation and flood forecasting with radar rainfall data in TC Members, and surveying the Radar Data application and operation rules in flood forecasting system in ROK. The Session also was informed that the project will be conducted field survey in selected target Members and upgrading the Extreme Flood Forecasting System (EFFS) with embedding the stochastic forecasting system.
66. The Session noted that, the project on Development and Application of Operational System for Urban Flood Forecasting and Inundation Mapping (OSUFFIM) for TC Members, which was

led by China, made remarkable progresses and achievement in 2018, including: a) determined the pilot cities in Vietnam, Malaysia and Philippines for OSUFFIM-II; b) set system running in Dongguan city of China; c) send expert missions to Hat Yai City of Thailand, Hue of Vietnam, and Penang of Malaysia in January 2018, September 2018, January and February 2019, respectively, for DEM data collection, system configuration, and software installation. d) published the technical report for OSUFFIM-I; and e) scheduled conclusion workshop for OSUFFIM-I which will be held in April or May 2019 in SYS University, Guangzhou, China.

67. The Session also was informed that, OSUFFIM-II will be conducted following activities in 2019: a) to continue updating OSUFFIM software; b) to maintain the operational system running in Hat Yai city of Thailand and Dongguan city of China; c) to conduct field survey for data collection and studying urbanization pattern in 2-3 selected pilot river basins in piloting Members; and d) to initialize setting up hydrological models in 3 new pilot river basins.
68. The Session was informed that, the project on Impact Assessment of Climate Change on Water Resource Variability in TC Members, which was officially launched in 2018 by China, has been stepped forward by conducting following activities: a) selecting the pilot watershed in sub-reach of the Yellow River and collecting hydro-meteorological data and general information for the selected watershed; b) analysing the hydrological features of the catchment and configuring the RCCC-WBM model; and conducting the 2-days on-jpb training for two piloting Members, namely Malaysia and Laos. The Session also was informed that, the project will conduct following activities in 2019: a) to select piloting river-basins for Malaysia and Laos; b) to send expert missions from China to Malaysia and Laos for guiding data collection and processing, and calibration of the Research Center for Climate Change (RCCC) Water Balance Model (WBM) model; and c) to put the RCCC-WBM model into operation in selected piloting river-basins.
69. The Session was informed that, Japan-side MLIT in cooperation with ICHARM purposed two new projects for WGH:
 - a. Flood Risk Watch Project for Life-saving
 - b. Platform on Water Resilience and Disasters under IFI (International Flood Initiative)
70. The Session was informed that, the Flood Risk Watch Project for Life-saving was proposed by MLIT of Japan for the period from 2019 to 2022 (can be extended) for sharing the technology of 3L (low cost, long life, localized) water level gauges in TC Members. The objectives of the project is to establish more effectively flood risk watching and information sharing for life saving. The Session also noted that activities for implementing the project in 2019 was proposed as: (a) field survey and meetings in partner country; (b) to hold one-day workshop at TC members; and (c) to introduce 3L water level gauge and system in TC Members
71. The Session was informed that, the Project of Platform on Water Resilience and Disasters under IFI was proposed by ICHARM of Japan for the period from 2019 to 2022 as one of TC cross-cutting projects. The objectives of the project were briefed as: (1) collecting and sharing data under the scheme of the platforms; (2) transferring knowledge and experiences; (3) enhancing the capacity and promoting the pilot projects; and (4) reducing the flood-disaster damage in the TC Members. The Session was also informed that the JMA is willing to join and contribute to the project from WGM side. The Session noted that activities for implementing the project in 2019 was proposed as: (a) to organize the session on the platform in the Philippines; (b) demonstrate the objectives and outcomes of the platforms in the current

implementing countries; and (c) conduct the preliminary study on how to establish the platforms in TC member countries.

72. The Session noted with appreciation that, WGH, with funding support from ISTRONG Technology of China, organized two seminars on Big-data application in Water-related Disaster Risk Early Warning and Reduction, including an one-day seminar on 12 October 2018 in Tokyo, Japan in conjunction with WGH 7th working meeting, and a two-day seminar from 22 to 24 February 2019 in Fuzhou, China in conjunction with the 3rd Think-tank Conference on Natural Disaster Prevention and Reduction of China which involved more than 150 participants including experts from Japan, Republic of Korea, Thailand and Vietnam.
73. The Session noted that, TC WGH webpage has been continue operating for sharing information among WGH members, and has been linked with TC Webpage (<http://www.typhooncommittee.org/wgh-web-page/>). The webpage will be updated and operated by HRFCO continuously in cooperation with KICT and TCS.
74. The Session was informed with pleasure that, based on the full discussion and communication on its 7th working meeting and TC 13th IWS, the following consensus have been reached in WGH on the issue of chairmanship:
 - a. to continue staying in chair/vice-chair system.
 - b. to give the chance to more Members for serving the Group and to mobilize more resource for WGH, the participants agreed to set up one more vice chairperson (3 in total) for the Group.
 - c. to propose Dr. Tetsuya Ikeda from Japan serve for WGH as Chairperson; Dr. CHO Hyo Seob from Republic of Korea, Dr. HOU Aizhong from China, and Mr. Kenneth Kleeschulte from Guam, USA serve for WGH as vice-chairs for approval at 51st Session.
 - d. to formulate an agreeable approach for future recommendation of appointment of Chairpersons and Vice Chairpersons for WGH before 53rd Session.
75. The Committee noted that, the current Chairperson of WGH Mr. Yoshio TOKUNAGA from ICHARM of Japan expressed his willingness to retire from his position after TC 51st Session. The Committee expressed its gratitude to Mr. Yoshio TOKUNAGA for his valuable contribution to WGH during his term in past 4 years since 2015.

CONCLUSIONS OF WGH

76. On the basis of the outcomes 7th WGH working meeting and the discussion of the WGH Parallel Session at 13th IWS, the following conclusions were reached:
 - a. To strengthen the execution of Cross-cutting project in the Committee so that to enhance the cooperation among three components. The new proposed project from Japan on Platform on Water Resilience and Disasters under IFI would be a good cross-cutting project among three working groups. The expected outcome and goals could be achieved and shared in TC Members based on the existing results and experiences between MLIT and JMA of Japan via the project.
 - b. To strengthen flash Flood and landslide forecasting and waring. The damage caused by flash Flood and landslide disasters shown a trend of increasing in Members, for example, the annual death caused by flash flood is reached around 70% of total annual death caused by flood disasters. Using advanced monitoring technology on big-data application in flash flood disaster risk forecasting and early warning could be a good

solution. China, Japan and Republic of Korea may share their experiences and results among TC Members.

- c. To strengthen the research and technical application on water resilience and disaster risk reduction under Climate Change. To enhance and improve the capacity of integrated water resource management (IWRM) under climate change is a pivotal issue in many TC Members. How to provide a platform for exchanging and sharing the experience on IWRM should be a topic for WGH to take actions.
- d. To strengthen the research and technical application on inundation mapping in urban region. The urban flood disaster in TC Members is increasing year by year. The achievements of projects of Flood Hazard Mapping (FHM) and Urban Flood Risk Management (UFRM), which were conducted by WGH in past years, should be widely extended in TC Members.
- e. Enhancement of the close collaboration with the AWG of WMO CHy, WMO RA II Working Group on Hydrological Services in several themes of common interest provides significant benefits to the Committee. WGH should take substantial measures to step forward.

RECOMMENDATIONS OF WGH

77. On the basis of the outcomes of 7th WGH working meeting and the discussion at the Parallel Session of 13th IWS and subsequent discussion, the WGH made the following recommendations:
 - a) To appoint Dr. Tetsuya IKEDA from Japan serve for WGH as Chairperson; Dr. CHO Hyo Seob from Republic of Korea, Dr. HOU Aizhong from China, and Mr. Kenneth Kleeschulte from Guam, USA serve for WGH as vice-chairpersons since 51st to 53rd Session.
 - b) to request US\$25,000 from TCTF in total for supporting WGH members participating TC 14th IWS.
 - c) to request US\$25,000 from TCTF in total for supporting overall WGH activities for 2019 calendar year.
 - d) to approve 2 new AOP proposals: (a) Flood Risk Watch Project for Life-saving led by MLIT of Japan from 2019 to 2022; (b) Platform on Water Resilience and Disasters under IFI led by ICHARM of Japan from 2019 to 2022 as a cross-cutting project of the Committee.
 - e) to request the Republic of Korea to host WGH 8th working meeting with funding support in early October 2019.
 - f) to request HRFCO to continue maintaining and operating the WGH webpage for effective sharing information among WGH members with support from KICT and TCS.
 - g) to appoint the focal point of WGH, Dr. JEONG HyeonGyo, HRFCO of the Republic of Korea as the liaison to WGH of WMO RA II for WGH of the Committee.
 - h) 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

78. The Committee reviewed the activities of WGDRR in implementing the TC Strategic Plan and its Annual Operating Plans (AOPs) in relation to DRR component during the past year. Details of which are presented in Appendix XVI.
79. The Committee was informed that 13h WGDRR Annual Workshop was successfully held in Ulsan, Republic of Korea from 29 to 31 May 2018 with the theme of “Public Understanding of Science on Disaster Risk Reduction from Desk to Field”, which was hosted and funded by National Disaster Management Research Institute (NDMI). ESCAP, WMO and AWG Members were also invited to join the meeting, beside WGDRR Members.
80. The Committee expressed its appreciation to National Disaster Management Research Institute (NDMI) for their kind contribution and continued support on WGDRR activities.
81. The Committee expressed its appreciation to the Working Group Chair, Dr. Jaehyun SHIM from the Republic of Korea for his remarkable contribution as the Chair of WGDRR in the past years.
82. The Committee expressed its appreciation to the Working Group Vice Chairs, Ms. Genevieve MILLER from USA and Dr. Yuntae KIM for their contribution and effort in the past years.
83. The Committee was informed that the projects (AOPs) for 2019 recommended by WGDRR as follow:
 - i. AOP1: Expert Mission- the project aims to exchange information and experience sharing related to DRR such as policies and technologies among the Members in order to improve the capacities on DRR. It was planned to continue conducting the Expert Mission in the interested Member state in 2019.
 - ii. AOP2: Setting up early warning and alert systems – The project is fund by NDMI. With installation of the EW and Alert Systems developed by NDMI, it improves the capacities of resilience for typhoon related disaster for participating members. NDMI has planned to continue carrying out the project in Laos and Vietnam in 2019.
 - iii. AOP3: WGDRR Annual Meeting- NDMI will continue organizing and funding the WGDRR annual workshop in order to facilitate follow-up of the WGDRR activities and information sharing related to DRR, as well as the communication among the Members.
 - iv. AOP4: Promote TC-PTC Cooperation: NDMI will invite PTC Member to join the 14th WGDRR annual workshop for information exchange and experience sharing related to disaster management, as well as discussion about the cooperation between TC and PTC on DRR activities.
 - v. AOP5: Participation in the BOSAI Forum - the Forum will be held in Sendai, Japan in November 2019. WGDRR planned to take part in the Forum in order to improve the capacities of disaster risk reduction among TC Members by exchanging DRR information and expertise with Forum’s participants, as well as introduce TC. WGDRR suggested other WGs to join the BOSAI forum for composing the TC session. For the cooperation between TC and PTC, WGDRR also suggested PTC members to join the forum.

- vi. AOP6: Benefit evaluation of typhoon disaster prevention and preparedness project- this project is led by Shanghai Typhoon Institute (STI), CMA that functions to establish a set evaluation index and provide an evaluation report that assists in decision-making basis for the optimization of typhoon disaster behavior. STI, CMA will provide a fellowship program to the interested Members for the project research in 2019. Miss ZHOU Xiao and CHEN Peiyan from STI, CMA will be the coordinators of the project.
- vii. AOP7: Supporting SSOP II Project- The SSOP Project Phase II that is aimed at implementing the Synergized Standard Operating Procedures (SSOP) for Coastal Multi-Hazards Early Warning System. The project originally will be terminated in November 2018. But the project has been extended to 2019 by ESCAP's approval. WGDRR will continue supporting the implementation of the Project.
- viii. AOP8: Sharing information related to disaster risk management- In order to improve the capacities of Members' Disaster Management, WGDRR will continue sharing information related to DRR through the established forum on TC website.
- ix. AOP9: Making education videos related to DRR- WGDRR will continue producing DRR education videos especially related to typhoon for sharing with TC Members in order to raise the public awareness on typhoon disaster.

CONCLUSIONS OF WGDRR

84. 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. Members have made important progress in the implementation of the TC SP during 2018
 - b. The 13th WGDRR annual workshop was successfully conducted in Ulsan, Republic of Korea from 29 May to 31 May 2018 with the theme of "Public Understanding of Science on Disaster Risk Reduction from Desk to Field". During the workshop, Working Group on DRR followed up on projects and shared information related to DRR among members. AWG Members and outside TC DRR experts were also invited to attend the workshop, besides the DRR Members. NDMI, Republic of Korea showed that they will continue organizing the 14th WGDRR annual meeting in 2019.
 - c. WGDRR will continue conducting the projects which can improve the capacities of disaster risk reduction for TC Members through the exchange of information such as expert mission and information sharing or participation in important conferences or meeting, etc.
 - d. WGDRR will continue planning the projects related to public education on DRR in the coming future which can facilitate raising public awareness on typhoon related disasters such as setting up of community weather stations and producing educational videos, etc.
 - e. To continue seeking the cooperation among the members and another regional body such as PTC on DRR activities.

- f. Compared with the projects last year, WGDRR suggested removing 2 projects namely TC Report about Big Data and Social Media use for DRR and iCoWin project. In 2019, total 9 projects will be executed based on the discussion at the meeting.
- g. For implementation of the proposed projects in 2019, WGDRR proposed the request of USD 21,500 to be allocated TCTF for the following items:
 - i. To allocate USD 6,000 budget of TCTF in 2019 for supporting the Expert Mission.
 - ii. To allocate USD 8,000 budget of TCTF in 2019 for supporting the participation in World Bosai Forum in Sendai, Japan.
 - iii. To allocate USD 6,000 budget of TCTF in 2019 for supporting the research fellowship, which will be held in STI, CHINA, related to benefit evaluation of Typhoon disaster prevention and preparedness.
 - iv. To allocate USD 1,500 budget of TCTF in 2019 to support producing an educational video provided by HKO related to DRR

RECOMMENDATIONS OF WGDRR

85. On the basic of the conclusion of discussion and deliberations, the WGDRR made the following recommendations:
- a) To appoint Mr. KIM, Seok-Hyeon as the Working Group Chair, and reappoint Dr. Yuntae KIM and Ms. Genevieve MILLER as the Vice Chairs.
 - b) To request NDMI to organize the Expert Mission that aims to improve the capacities of disaster management through knowledge exchange and experience sharing among TC Members.
 - c) To encourage the benefited members to actively participate in the final training workshop of the SSOP Project II and DRR members to support the Project's implementation.
 - d) To request NDMI to organize the participation for TC and PTC Members in Bosai Forum in Sendai, Japan.
 - e) To request NDMI to invite Oman, PTC Member attending 14th WGDRR Annual Meeting in the Republic of Korea in order to discuss the cooperation and exchange DRR information.
 - f) To request STI, CMA to continue conducting the research fellowship for the project of benefited evaluation of typhoon disaster prevention and preparedness to the interested TC Members.
 - g) To request Hong Kong, China to translate an existing video related to storm surge into English with subtitles for Member to use on public education on DRR.
 - h) To request NDMI, Republic of Korea to continue supporting and conducting the 14th WGDRR Annual Workshop in 2019.
 - i) To request NDMI to continue supporting and implementing the establishment of the early warning and alert systems in Lao PDR and Vietnam and encourage the other Members to join the project in the future.
 - j) To encourage the Members to share information related to DRR on the forum of TC Website.

- k) To request the committee to approve the proposed projects and related budget in 2019.

8.4. Training and Research Coordination Group (TRCG)

86. The Committee took note of the progress made in training and research activities as presented in the TRCG Report 2018 (Appendix XVII)
87. The Committee noted the successful completion of the Technical Conference (TECO) in conjunction with the 50th Session of the Typhoon Committee (TC50) in February 2018 and expressed its gratitude to Viet Nam Meteorological and Hydrological Administration for hosting the TECO in Hanoi and the contribution of speakers in the event.
88. The Committee expressed its appreciation to the Meteorological Service Singapore for hosting the Roving Seminar 2018 in Singapore and the support of resource persons by China, Hong Kong, China, and Japan.
89. The Committee thanked China, Hong Kong, China and Republic of Korea for hosting research fellowship programs in 2018.
90. The Committee took note of the successful completion of the RSMC Tokyo Training Attachment of five forecasters from TC and PTC Members, including Macao, China, Malaysia and the Philippines of the Typhoon Committee as well as two forecasters in the Panel on Tropical Cyclone, and thanked Japan and WMO TCP for continuously supporting this capacity-building initiative.
91. The Committee expressed its appreciation to China for offering the Typhoon Forecaster Training for seven forecasters from TC and PTC including Thailand, Viet Nam, Malaysia, Lao PDR, Bangladesh and Sri Lanka.
92. The Committee appreciated TRCG's inputs in support of training and research activities in connection with TC's cross-cutting projects.

RECOMMENDATIONS OF TRCG:

93. 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 Report 2018.
 - c) To endorse the proposal of increasing the number of Typhoon Committee trainees for the RSMC Tokyo Training Attachment from 3 to 4, starting from 2019, with the same cost-sharing scheme for WMO TCP and TCTF to cover the additional ticket and lump sum respectively.
 - d) To endorse the TRCG AOP 2019 including the hosting of the roving seminar under the support of TCTF and other budget requests which are included in the budget proposal to be submitted by AWG.

X. REPORTS OF THE TCS AND AWG (agenda item 10)

10.1 Activities of TCS

94. The Committee took note of the report of the Typhoon Committee Secretariat, as presented in Appendix XVIII.
95. The Committee noted with appreciation the TCS's activities 2018 in order to enhance coordination and support to Members, improve the cooperative mechanism between TC and PTC, implement SSOP II project, increase the visibility of Typhoon Committee via the social media, improve the TC website for sharing the forecast products and information, coordinate Working Groups activities, and keep TCS operation smoothly when Typhoon Mangkhut hit Macao, China and the office was damaged.
96. The Committee noted with high appreciation that Government of Macao, China for the strong support to TCS in the past years, and for continuing hosting TCS for the 4th term from 2019 to 2022, and for cooperating to renew and implement the Agreement between the Government of the Macao Special Administrative Region of the People's Republic of China and the ESCAP/WMO Typhoon Committee regarding Administrative, Financial and Related Arrangements for the Typhoon Committee Secretariat.
97. The Committee expressed appreciation to Members for their contribution for the Typhoon Committee Trust Fund and in-kind contributions and encourage Members to continue support activities of the Committee.
98. The Committee noted with appreciation Mr. Tom Evans, Project Manager of SSOP II and Members related for their efforts on implementation of SSOP phase II to benefit more Members of the TC and PTC.
99. The Committee approved the recommendations submitted by TCS as expressed in point 6 of Appendix XVIII.

9.2 Activities of AWG

100. The Committee was informed of the activities of the AWG as presented in the AWG Report 2018 in Appendix XIX.
101. The Committee was briefed on the major issues discussed at the AWG meetings in Ha Noi, Viet Nam on 3 March 2018, in Ulsan, Republic of Korea on 1 June 2018, and in Chiang Mai, Thailand on 4 and 9 November 2018.
102. The Committee was informed of the proposed budget for 2019, including items in support of non-recurring items for special funding consideration.
103. The Committee was informed on the progress of the SSOP-II Project.
104. The Committee was informed on the status of the WGH Chairpersonship issue.

RECOMMENDATIONS OF AWG

105. The AWG made the following recommendations

- a) Recognize and thank Viet Nam for their exceptional effort in hosting the highly successful Typhoon Committee 50th Annual Session in Ha Noi, Viet Nam.
- b) Recognize and thank Thailand for their exceptional effort in hosting the 13th Integrated Workshop in Chiang Mai, Thailand.
- c) Welcome Dr. Hisaki EITO, Head of Tokyo Typhoon Center, as the new Vice Chair of the AWG and reappoint Mr. Raymond TANABE and Dr. Tsz-Cheung LEE, Chair and Vice-Chair, respectively.
- d) Take note of the progress and recommendations made in the planning and implementation of TC activities, including the preparation of the budget for 2019.
- e) Review and provide comments on the 2019 work plan for the SSOP-II project conclusion.

XI. PROCEDURES FOR NEW MEMBERSHIP OF TYPHOON COMMITTEE (agenda item 11)

106. The Committee took note of the proposed procedures for new Membership in the Typhoon Committee, presented in Appendix XX.

107. The Committee request TCS and AWG to develop a final proposal to include the procedures for the approval at the 52nd Session.

XII. PUBLICATIONS (agenda item 12)

108. The Committee took note of the publications of the Typhoon Committee in 2018.

109. The Committee noted with appreciation the all Member's 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.

XIII. PROGRAMME FOR 2019 AND BEYOND (agenda item 13)

13.1. TC Secretary New Term 2019/2022 early 2023

110. The Committee took note the nomination of TC Secretary for the Term 2019/2022 early 2023, as presented in Appendix XXI.

111. The Committee approved the reappointment of Mr. YU Jixin, as the Secretary of the Typhoon Committee, from 2019/2022 early 2023

13.2. Retired and new tropical cyclone names

112. The Committee noted Japan provided KUJAKU, KOINU and OTOME as replacement names for TEMBIN, and YAMANeko, TOKEI and SANKAKU as replacement names for HATO.
113. The Committee noted Hong Kong, China provided YUN-YEUNG, LU-FENG and TAI-GIK as replacement names for KAI-TAK.
114. The Committee noted the request from Philippines to retire the name of tropical cyclone MANGKHUT and request Thailand to provide replacement names.
115. The Committee noted the request from China to retire the name of tropical cyclone RUMBIA and request Malaysia to provide replacement names.

XIV. COORDINATION WITH OTHER ACTIVITIES OF THE WMO TROPICAL CYCLONE PROGRAMME (agenda item 14)

116. The Committee was presented about activities under, and those requiring coordination through, TCP (Appendix XXII). It appreciated the comprehensive presentation, and thanked WMO support to the Committee.
117. The Committee was informed by the WMO Secretariat that the 70th session of the WMO Executive Council (EC-70) made further decisions in relevance to the work of TCP. e.g. WMO DRR Roadmap, development of WMO Global Multi-Hazard Alert System (GMAS), Seamless GDPFS, IBF, and constituent bodies reform, etc.
118. The Committee was informed that the Global Guide to Tropical Cyclone Forecasts has been reformatted with more readable and easily printable format. It can be downloaded at <https://cyclone.wmo.int/>.
119. The Committee was presented by WMO Secretariat about Recommendations of the Ninth International Workshop on Tropical Cyclones (IWTC-9) which happened in Honolulu, Hawaii, USA, 3-7 December 2018, and the outcomes and recommendations from the Ninth RSMCs/TCWCs Technical Coordination Meeting (TCM-9) (Honolulu, Hawaii, USA, 9-12 December 2018).
120. The Committee was informed that TCP activities during the inter-sessional period were mainly focused on following aspects:
 - Training and Capacity Development
 - Support to Operational Forecasting
 - Global and Regional Coordination of Forecasting Services
 - Support to DRR endeavours associated with tropical cyclones
121. The Committee was informed that collaborative efforts were made by the TCP and WWRP for promoting application of research outcomes to operational forecasting within the framework of the Typhoon Committee to implement the Typhoon Landfall Forecast Demonstration Project (TLFDP) including EXOTICCA (Experiment on Typhoon Intensity Change in the Coastal Area), and the Research and Development Project of Understanding and PreDiction

of Rainfall Associated with landFalling Tropical cyclones (UPDRAFT). WWRP is planning an annual meeting on progress of these three projects in the 3rd quarter of the year.

14.2. Coordination with ESCAP activities on DRR

122. The Committee took note of the ESCAP's analytical work on disaster risk reduction. (Appendix XXIII)
123. The Committee took note of the Asia-Pacific Disaster Resilience Network, the ESCAP's overall work programme on disaster risk reduction, and expressed its support for its implementation.

XV.SUPPORT REQUIRED FOR THE COMMITTEE'S PROGRAMME (agenda item 15)

15.1. Technical Cooperation

124. The Committee was informed that there's no technical cooperation presentation.
125. The Committee appreciated the recent initiative by Hong Kong, China to equip a search and rescue fixed-wing aircraft with an AVAPS (Airborne Vertical Atmospheric Profiling System) for operational tropical cyclone reconnaissance over the Hong Kong Flight Information Region (FIR), the data of which has been shared with WMO Members operationally and successfully assimilated into numerical weather prediction models in real time.
126. The Committee noted the great threat posed by tropical cyclones to life and property, and the benefit of reconnaissance flights in improving tropical cyclone track and intensity forecast and its contribution towards disaster risk reduction and multi- hazard early warning of tropical cyclone, and considered it advantageous if the reconnaissance flights could be extended to other regions through a coordination and collaborative effort of interested Members.
127. The Committee invited interested Members to explore the feasibility of developing a coordination mechanism, with the support from their air traffic authorities, to facilitate the operation of reconnaissance flights into tropical cyclones across multiple FIRs and sharing of the resulting meteorological data.

15.2 Update of Accounting issues with WMO and TC

128. WMO representative presented to the Committee with the outcomes of the AWG meeting in Chiang Mai, Thailand, 9 November 2018, with regard to the auditing results of the TCTF by WMO external auditors, and the follow-up actions taken by WMO.
129. The Committee discussed the WMO external auditors' recommendations on TCTF, noted with appreciation the actions taken by WMO in response to the outcomes from the above AWG meeting
130. The Committee agreed:
 - a) To continue with the current practice, i.e. to present the IPSAS financial statements for TCTF in CHF for auditors, and to report the TCTF to the Committee in USD.

- b) That the Committee's annual workplan be formulated in alignment with WMO financial cycle, i.e. 1 January – 31 December, with additional three months of the following year to be included in the annual workplan to facilitate the convenience of implementing the activities of the Committee.

15.3. Typhoon Committee Trust Fund (TCTF)

131. The Committee reviewed the statement of account of TCTF for the period of 1 January to 31 December 2017 and the provisional statement for 1 January 2018 to 31 December 2018 submitted by the representative of the WMO Secretariat as shown in Appendix XXIV.
132. The Committee noted the request of WMO in encourage the Members to contribute on the TCTF.
133. The Committee was informed by TCS, the summary of income and expenditure from 1 January 2016 to 31 December 2016 and 2017 to 31 March 2018 and the provisional summary of income and expenditure from 1 April 2018 to 31 March 2019 related to the execution of the Work Plan 1 January to 31 December 2016, 2017 to 31 March 2018 and from 1 April 2018 to 31 March 2019 (Appendix XXV).

15.4. In-kind Contributions

134. The Committee expressed appreciation for the in-kind contributions from some Members, namely China, Hong Kong, China; Japan, Macao, China; Republic of Korea, Singapore, Thailand and Viet Nam. The Committee also invited the 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 XXVI).
135. The Committee also expressed the importance of having in-kind contributions with correspondence values and encourage more Members to contribute with in-kind contribution on the TC activities.

15.5. Approval of Typhoon Committee Trust Fund (TCTF) 2019/2020 Budget

136. The Committee took note of the proposed reallocation of normal and special budget 2019/2020 by WG's Chairs and TCS.
137. The Committee discussed and approved the budget for 2019/2020 (Appendix XXVII).

XVI. DATE AND PLACE OF THE 14TH IWS (agenda 16)

138. The Committee was informed that the Guam, USA will host the 14th IWS. The proposed dates are 04-07 November 2019. The final date will be confirmed in due course by USA and later communicated to TCS.

XVII. HOSTING OF THE 15TH IWS (agenda 17)

139. The Committee was informed that Viet Nam are willing to host the 15th IWS in 2020. The final date and place will be confirmed in due course by Viet Nam and later communicated to TCS.

XVIII. DATE AND PLACE OF THE 52ND TC SESSION (agenda 18)

140. The Committee was informed that Hong Kong, China will host the 52nd Session. The proposed dates are tentatively late February 2020. The final date will be confirmed in due course by Hong Kong, China and later communicated to TCS.

XIX. HOSTING OF THE 53RD TC SESSION (agenda 19)

141. The Committee was informed that Japan is willing to host the 53rd Session of Typhoon Committee in 2021. The final date and place will be confirmed in due course by Japan and later communicated to TCS.

XX. RESULTS OF TC50 PHOTO CONTEST (agenda 20)

142. The Committee noted with appreciation the submission of photos for the TC50 Photo Competition. After the voting during the Session, the results were announced with the following winners:
- 1st Prize: Viet Nam
 - 2nd Prize: China and Hong Kong, China
 - Consolation Prize: China and Japan

XXI. OTHER BUSINESS (agenda item 20)

143. The Committee noted that Japan will host the Asia-Pacific Water Summit in 19-20 October, 2020 in Kumamoto, Japan.

XXII. ADOPTION OF THE REPORT (agenda item 21)

144. The Committee adopted the report of the session at 10:38 am, 01 March 2019.

XXIII. CLOSURE OF THE SESSION

145. The delegates from the Members of the Typhoon Committee, representatives of WMO, ESCAP and TCS expressed their thanks and appreciation to China for the successful hosting for organizing the Fifth-First Session of the Typhoon Committee. They also expressed gratitude to Mr. YU Yong, Deputy Administrator of CMA and his staff for the warm hospitality and excellent arrangements made.
146. The Session was closed by the Chairperson at 11:02 am, 01 March 2019.