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Report on Activities of Working Group on Hydrology (WGH) of TC in 2017

(Item 9 of Tentative Program for TC 49th Session)

(Submitted by WGH)

ACTION REQUIRED:

This Committee is invited to:

a) Review the activities of TC WGH conducted in 2017
b) Approve the recommendations and AOPs of WGH for 2018 and beyond

APPENDIXES:

I. DRAFT TEXT FOR INCLUSION AT SESSION REPORT

II. Report on activities of Working Group on Hydrology (WGH) of TC in 2017

APPENDIX I

DRAFT TEXT FOR INCLUSION AT SESSION REPORT

8.2 Hydrological Component

1. 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 ??.**

2. 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, 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 2017.

3. The Session noted with pleasure that, the 6th WGH working meeting was successfully held from 25 to 28 September 2017 in Seoul, the Republic of Korea (ROK) with theme of "Adaptive Capacity Building for Extreme Flood Preparedness". About 20 participants from 8 Members namely China, Japan, Laos, 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 the Ministry of Land, Infrastructure and Transport (MOLIT) of ROK, through Han River Flood Control Office (HRFCO) with cooperation of Korea Institute of Civil Engineering and Building Technology (KICT), for generously hosting the meeting.

4. The Session noted with appreciation that, Japan expressed its willingness to host WGH 7th Working Meeting in September 2018. The meeting is temporarily proposed 4 days, including one-day workshop for the project led by Japan, namely Flash Flood Risk Information for Local Resilience, and one-day seminar to be funded by China on Decision Supporting to SOP for Costal Multi-hazards Early Warning and Reduction.

5. The Committee was informed on the implementation status in 2017 and future activities of on-going projects (AOPs):

   a) Flash Flood Risk Information for Local Resilience
   b) Extreme Flood Forecasting System
   c) Guidelines for Extreme Flood risk Management in TC Region
   d) Development and Application of Operational System for Urban Flood Forecasting and Inundation Mapping (OSUFFIM) for TC Members
   e) Application of Hydrological Data Quality Control System in TC Members
   f) Enhancement of Flood Forecasting Reliability with Radar Rainfall Data and Stochastic Technique
   g) Impact Assessment of Climate Change on Water Resource Variability in TC Members

6. The Session was informed that, the Ministry of Land, Infrastructure and Transport (MLIT) and the International Centre for Water Hazard and Risk Management (ICHARM) of Japan has put the project of Flash Flood Risk Information for Local Resilience substantially forward in 2017, including analyzing the Members' disaster prevention policies by using questionnaire and exchanging information in WHG meetings. The Session also noted with pleasure that Japan will promote the collaboration between this AOP and the "National Platform on Water and Disaster" project of the International Flood Initiatives in 2018 and beyond.

7. The Session was informed that, two projects led by Republic of Korea, namely a) Extreme Flood Forecasting System (EFFS), and b) Guidelines for Extreme Flood Risk Management in TC Region, have been closed successfully in 2017. The technical reports have been published in 2017 as two publications of the Committee (TC/TD-No. 0015 and TC/TD-No. 0016) and distributed at 12th Integrated Workshop which was held in Jeju, Republic of Korea from 30 October to 03 November 2017. The operation system for EFFS has been installed in pilot Members, namely Lao PDR, Philippines, ROK and Thailand. The Session also noted with appreciation that, the HRFCO and KICT committed to continue improving the functions of EFFS, and continue providing the technical support to Members.

8. The Session was informed 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 2017, including: a) software updating and system configuration for Dongguan City of China, Hat Yai City of Thailand; b) field survey missions in Malaysia from 24 to 31 August 2017 and in Vietnam from 13 to 19 November 2017; c) experts from Department of Irrigation and Drainage (DID) of Malaysia and Royal Irrigation Department (RID) of Thailand working in SYS University from 19 to 21 April 2017 and from 20 to 22 October 2017, respectively; d) OSUFFIM workshop was held in SYS University from 27 to 30 December 2017, with participants from China, Myanmar, Malaysia, Philippines, Thailand and Vietnam as well as TCS; and e) experts of SYS University working in Hat Yai, Thailand for geographic data collection from 29 January to 3 February 2018. The session also noted with appreciation that, SYS University generously provided funding and expertise support for implementation of OSUFFIM.

9. The Session noted that, the project of OSUFFIM was proposed to be closed at 50th Annual Session of TC, in order to extend the achievement to more TC Members, WGH will conduct phase-II for OSUFFIM in a period of 3 more years from 2018 to 2020 with objectives of a) updating OSUFFIM software and application in new selected pilot cities in 2-3 interested Members; and b) studying the trend of urban flood pattern in TC Members under a changing climate and urbanization. The Session also noted with appreciation that, Prof. CHEN Yangbo of SYS University, as chief scientist of OSUFFIM, is willing to contribute his knowledge and share his expertize on urban flood forecasting and inundation mapping to the Members.

10. The Session was informed that, WGH will officially launch three new initiatives in 2018 based on the detail discussion and communication at 6th WGH working meeting and 12th TC Integrated Workshop, including:

a) Application of Hydrological Data Quality Control System in TC Members. The purpose of the project is to support and provide the guideline and system to improve the quality control of hydrological data in TC regions. The project is proposed to be driven by HRFCO of Republic of the Korea in cooperation with KICT in a period of 5 years from 2018 to 2022, with objectives of: (1) enhancement of TC Member's capacity for managing & monitoring of hydrological data (Rainfall, Water Level, Discharge); (2) reducing the uncertainty of input data for flood forecasting; (3) suggesting the procedure of producing hydrological data; and (4) establishment of the hydrological data quality control system linkage to EFFS.

b) Enhancement of Flood Forecasting Reliability with Radar Rainfall Data and Stochastic Technique. The purpose of the project is to upgrade the developed EFFS, especially flood forecasting technology using radar data and probabilistic flood forecasting technology. The project is proposed to be driven by HRFCO of the Republic of Korea in cooperation with KICT in a period of 5 years from 2018 to 2022, with objectives of: (1) enhancing TC Member's capacity for flood forecasting using radar rainfall data & stochastic techniques; (2) upgrading the LEVEL3 module of EFFS; (3) evaluating the uncertainty of flood forecasting, and suggesting the procedure of stochastic flood forecasting.

c) Impact Assessment of Climate Change on Water Resource Variability in TC Members. The purpose of this project is to collect, collate, analyst, evaluate and develop the water resources modelling information for better decision management system so that to improve the capacity building among TC Members on better understanding water modelling and water resources management. The project is proposed and will be drove by Hydrological Forecasting Center (HFC) of MWR, China in cooperation of Nanjing Hydraulic Research Institute (NHRI) with the objective of extending the application of the Water Balance Model (WBM) developed by the Research Center for Climate Change (RCCC) of the Ministry of Water Resources (MWR), China to assess the impact of climate change to water resource variability in TC Members so as to providing the sustainable water resources information to the Member Governments on water resources management and social-economic planning in the country.

11. The Session noted that, WGH established the project–bank for next years under TC Strategic Plan and the strategic framework of ESCAP and WMO on water-related disaster reduction, which mainly focuses on enhancing the knowledge and capacity building on the management of water-related disaster risks for a resilient future in Typhoon Committee region, including:

— Innovative flood forecasting for ungauged river basin;
— Flash flood (landslide, mud-flow) prediction and warning using QPE/QPF;
— Extension the application of urban flood forecasting and inundation mapping;
— Rainfall-runoff inundation mapping for river basins;
— Radar and satellite data utilization in flood forecasting and warning;
— Long-term forecasting for water resource management and drought monitoring and warning under climate change;
— Data-sharing in transboundary rivers;
— Dam operation for flood risk management under climate change;

12. The Session noted that, TC WGH webpage has been operated 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.

13. The Session was informed that, following the decision of TC 49th Session, WGH at its 6th working meeting coordinated and selected Mr. Yoshio Tokunaga from ICHARM of Japan and Dr. CHO Hyo Seob from HRFCO of the Republic of Korea continue working as Chairperson and vice chairperson of WGH, respectively, to TC 51st Session. Dr. HOU Aizhong from HFC of China continues serving as Vice-chairpersons of WGH to 51st Annual Session.

14. The Session noted that, based on deep discussion at TC 12th IWS, WGH requested AWG to discuss and consider the possibility of Chair/Co-Chair system for WGH and to advise WGH Chairmanship for the final decision. The Session also noted that, AWG has discussed this matter and had an initial comprehensive consideration at its meeting at TC 12th IWS held in Jeju, Republic of Korea. The Session also noted with a pleasure that WGH expressed to be obligated to follow the advice from AWG as final solution.

CONCLUSIONS OF WGH

15. On the basis of the outcomes 6th WGH working meeting and the discussion of the WGH Parallel Session at 12th IWS, the following conclusions were reached:

- The working meeting of WGH is very important to review hydrological activities, deep technical discussion and implementation status of WGH AOPs, and also is very necessary to prepare IWS and annual session. The funding support and contribution from the Republic of Korea played the vital role in organizing the annual working meeting in past years. WGH encourages the more and wider resources to support the activities to keep its sustainability.
- To promote the capacity of forecasting, early warning and risk management for urban flood is an urgent need among TC Members, especially urban flood forecasting and inundation mapping. As the subsequent activity of TC first Cross-cutting project of Urban Flood Risk Management (UFRM), the on-going project of WGH on Development and Application of Operational System for Urban Flood Forecasting and Inundation Mapping (OSUFFIM) is a tangible measure on this aspect and it will play very meaningful and important role for TC Members to promote the capacity on the technique of urban flood forecasting and warning.
- Acquirement of the high quality hydrological data is the most basic work in flood forecasting. However, most of TC Members do not have adequate quality control system of hydrological data. The suggestion of HRFCO for new AOP regarding data quality control system is very meaningful for TC members to promote their capacity of flood forecasting and warning with better hydrological data.

- In TC Members, water is considered as the core of sustainable development and a critical element for its socio-economic development. Water is the driver of the key sectors of its economy and will remain as a crucial element to sustain its healthy ecosystem which eventually affects the well-being of its population. Water is a finite resource and it is only renewable if well managed. Water can pose serious challenges to sustainable development but if managed efficiently and equitably, water would play a key enabling role in strengthening the resilience of social, economic and environmental systems in the light of rapid and unpredictable changes. Therefore, one of the key elements in managing water resources is to provide a comprehensive management instrument which could provide multiple functions including accounting for water resources, providing real time via on-line information and long term (projection) on water availability and variability, an assessment tool to evaluate operation options for efficient water allocation and a forecasting system to assist in the decision making process. It is necessary and important for WGH to conduct the cooperation on Impact Assessment of Climate Change on Water Resource Variability among TC Members for implementation of KRA 3 of Strategic Plan 2017-2021.
- 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.

RECOMMENDATIONS OF WGH

16. On the basis of the outcomes of 6th WGH working meeting and the discussion at the Parallel Session of 12th IWS and subsequent discussion, the WGH made the following recommendations:

- to appoint Mr. Yoshio TOKINAGA from ICHARM of Japan as Chairperson of WGH; Dr. CHO Hyo Seob from HRFCO of the Republic of Korea and Dr. HOU Aizhong from HFC of China as vice chairperson of WGH, to TC 51st Annual Session.
- to request AWG to advise on the matter of Chairmanship for WGH as the final solution. Before that, WGH will follow its current TERMS OF REFERENCE in a consultative and harmonized manner.
- to request US$10,000 from TCTF in total for supporting WGH members participating TC 13th IWS.
- to request US$15,000 from TCTF in total for supporting overall WGH activities for 2018 calendar year.
- to request US$3,000 special budget to support publishing OSUFFIM technical report in 2018;
- To request MLIT and ICHARM of Japan to host WGH 7th working meeting with funding support in September 2018.
- to approve the proposal to conduct phase II for OSUFFIM as a continual project in a period from 2018 to 2020;
- to approve the initiatives of two AOPs in the period from 2018 and 2022 proposed by HRFCO of the Republic of Korea with cooperation of KICT: (1)

Application of Hydrological Data Quality Control System in TC Members; and (2) Enhancement of Flood Forecasting Reliability with Radar Rainfall Data and Stochastic Technique.

- to approve the project in the period from 2018 and 2020 proposed by HFC of MWR and NHRI of China: Impact Assessment of Climate Change on Water Resource Variability in TC Members.
- to request HRFCO to continue maintaining and operating the WGH webpage for effective sharing information among WGH members with support from KICT and TCS;
- To re-appoint the focal point of WGH, Ms. Ji-Youn SUNG, HRFCO of the Republic of Korea as the liaison to WGH of WMO RA II for WGH of the Committee.
- To continue focusing on improving the ability to forecast hydrological phenomena and provide measures for the effectiveness of the improvements.

APPENDIX II

Report on Activities of Working Group on Hydrology (WGH) of TC in 2017

In 2017, Working Group on Hydrology (WGH) of Typhoon Committee (TC) conducted a series of activities very positively referring to the decision of 49th Session which was held at in Yokohama, Japan from21to24 February 2017. This report was drafted mainly on the base of the outcomes of 6th WGH working meeting which was held in Seoul, the Republic of Korea from 25 to 28 September 2017, and the discussion of the parallel session of TC 12th Integrated Workshop (IWS) which was held in Jeju, the Republic of Korea from 30 October to 03 November 2017.

The report highlighted the main progresses and achievements on hydrological component in Members in past year; briefly described the activities of WGH conducted in 2016, and summarized the status of implementation of WGH AOPs 2017. Based on the communication among Members and the discussion at TC 12th IWS, WGH proposed the implementation plan of AOPs for 2018 and beyond; and consequently requested the TCTF allocation for supporting WGH activities in the year of 2018.

I. The Major Progresses on Hydrological Component in Members in 2017

1) The WGH reviewed the hydrological activities conducted in Members in 2017 and noted the major progresses which may benefit other Members.

2) In China, a new system taking the impact-forecast and risk-warning into consideration is now being developed. In this system, not only the discharge and water level at specific section is predicted, but also the inundation area, depth and duration are calculated. In this connection, the impact and risk of flood to population, property, agriculture, industry and environment can also be evaluated, which can be used directly for DRR department.

3) In Malaysia, multi-flood disasters: especially monsoon flood and urban flash flood always occurs and the numbers increasing every year. Between January to October 2017, 278 flood events has been recorded compare to the 200 events as average annual flood. To date, the Department of Irrigation and Drainage (DID) has been develop 811 hydrological telemetry stations, 876 manual flood gauges, 103 flood warning boards and 472 automatic flood warning sirens in flood prone areas. Furthermore, six flood forecasting models have been deployed for selected river basins to provide flood forecast warning for the disaster's agencies as well as to the public. Currently, there are several flood forecasting model being developed by the DID, namely the National Flood Forecasting and Warning System for Kelantan, Terengganu and Pahang river basin and expected to be completed by October 2018. Malaysia also committed to the programmed carry out by ESCAP/WMO Typhoon Committee under Annual Operating Plan (AOP 4): The application of Operational System for Urban Flood Forecasting and Inundation Mapping (OSUFFIM). The preliminary field survey has been successfully conducted in the August 2017 and the selection of the river basin for the case study will be finalize during workshop held in Guangzhou (27 Nov - 1 Dis 2017).

4) In Philippines achieved on improvement of hydro-meteorological monitoring facilities and Radar data application (6 x-band Radars).

5) In the Republic of Korea made progresses on the development of flood forecasting system, TC WGH webpage, and flood information service system.

6) In Thailand, RID provided the effective flood information to public; established the Smart Water Operation Center (data bank), including sub-committee for monitoring and analyze water situation trends; public relations and warning (socio-media in dissemination of information and warding) and etc.

7) In Viet Nam, big disasters caused by flood and inundation; flash flood and landslide. National Center of Meteorological and Hydrological Forecasting (NCMHF) updated the early warning system (three levels); and made progress on forecasting technology; transmission and monitoring hydro-meteorological disasters.

8) The hydrological departments in the Members provided valuable service of flood forecasting and warning to the decision-making departments of the Governments and public.

II. Review of the sixth WGH Working Meeting

9) The 6th WGH working meeting which was held in Seoul, the Republic of Korea from 25 to 28 September 2017.

10) The meeting was hosted by the Han River Flood Control Office (HRFCO), Ministry of Land, Infrastructure and Transport (MOLIT) of the Republic of Korea (ROK) in cooperation with Korea Institute of Civil Engineering and Building Technology (KICT) with the generous offer of financial support, and co-chaired by WGH chairperson Mr. Tokunaga YOSHIO and the vice chairperson Dr. Hyo-Seob CHO.

11) The meeting was attended by about 20 participants from 8 Members, namely China, Japan, Laos, Philippines, the Republic of Korea, Thailand, USA and Vietnam. Dr. Jinping LIU, the hydrologist of TCS took part in the meeting.

12) The theme of the meeting was proposed as "Adaptive Capacity Building for Extreme Flood Preparedness" with the following purposes:

- to review the implementation status and progresses of WGH Annual Operating Plan (AOP) in 2017;
- to present new initiatives for WGH AOPs and discuss the implementation plans of WGH Annual Operating Plan (AOP) in 2018;
- to discuss the preparation for the 12th Integrated Workshop and 50th Annual Session;
- to coordinate and select Chairperson of WGH following the decision of 49th Session.

13) The participants expressed their heartfelt appreciation to MOLIT, through HRFCO with cooperation of KICT, for kindly hosting the meeting and for all the excellent hospitality and logistic arrangement.

14) Japan expressed its willingness to host WGH 7th Working Meeting in Japan. The meeting is temporarily proposed 4 days, including one-day workshop for AOP1 led by Japan, namely Flash Flood Risk Information for Local Resilience. and one-day seminar to be funded by China on Decision Supporting to SOP for Costal Multi-hazards Early Warning and Reduction.

III. Progresses of WGH AOPs in 2017 and Implementation Plan for 2018

15) The implementation status and the success indicators of WGH AOPs in 2017 were reviewed and discussed. The project leaders from China, Japan and Korea presented the progresses on AOPs achieved in 2017 and implementation plan for 2018. The WGH AOPs in 2017 and beyond was summarized in the table 1. The implementation status of WGH AOP 2017 is summarized in the Annex 1 and the success indicators of AOPs in 2018 are shown in Annex 2.

Table 1 the Summary of WGH AOPs in 2017 and Beyond

	Projects	Driver	Duration
AOP1	Flash Flood Risk Information for Local Resilience	Japan	2017~2019
AOP2	Extreme flood forecasting system	Korea	2012~2017
AOP3	Guidelines for extreme flood risk management in TC region	Korea	2013-2017
AOP4	Development and Application of Operational System for Urban Flood Forecasting and Inundation Mapping (OSUFFIM) for TC Members	China	2014~2017
AOP5	Application of Hydrological Data Quality Control System in TC Members	Korea	2018-2022
AOP6	Enhancement of Flood Forecasting Reliability with Radar Rainfall Data and Stochastic Technique	Korea	2018-2022
AOP7	Impact Assessment of Climate Change on Water Resource Variability in TC Members	China	2018~2020

AOP1: Flash Flood Risk Information for Local Resilience

16) WGH reviewed the progresses of the project of Flash Flood Risk Information for Local Resilience in 2017 and the implementation plan in 2018 briefed as below:

- In 2017, MLIT of Japan and ICHARM put forward its outputs and activities for the whole period and analyzed the member countries' disaster prevention policies by using questionnaire and exchanging information in WHG meetings and so on.
- In 2018, Japan will make an interim report on actual disaster experiences and cases of good practice in terms of disaster prevention policy, emergency response, restoration and reconstruction, and then systematically sort out the information.
- In 2018, Japan will promote collaboration between AOP1 and the "National Platform on Water and Disaster" project of the International Flood Initiatives. As the first step, Japan will introduce existing networks and their activities to the WGH Members and discuss potential sites in member countries.

17) ICHARM and MLIT will hold one-day workshop on AOP1 together with the 7th WGH meeting in Japan in September 2018 with partial funding support from TCTF for their operation.

18) The WGH members recognized the importance of the project in practice and expressed the willingness to be involved in the activities and apply the method in the flash flood risk reduction in their countries.

AOP2: Extreme Flood Forecasting System (EFFS)

19) WGH reviewed and summarized the activities and achievement of the project of Extreme Flood Forecasting System (EFFS) since 2012, which will be closed at TC 50th Annual Session.

20) The progresses of AOP2 in 2017 were summarized as following:

- The establishment of extreme flood forecast system almost has been completed as Level-1(stage method), Level-2(Rainfall-Runoff model), Level-3(Flood Forecasting using radar data) with PC-version, and Level-4(Establishment of Emergency Action Plan).
- The system file will be uploaded on TC WGH webpage after closing of 12 IWS.
- The technical report, including theoretical background and user manual, is published as one of TC Publications in 2017 and distributed at 12th IWS.
- The TC WGH webpage has been operated for sharing information among WGH members, and has been linked with TC Webpage (http://www.typhooncommittee.org/wgh-web-page/), will be operated continuously with support from TCS.

21) The programme of EFFS was installed in the laptops of participants and had demonstration. The representatives of three participating Members, namely Lao PDR, Philippines and Thailand presented the status of flood forecasting in their countries. All participants expressed their willingness to apply EFFS in practice so that to promote their capacity on real-time operational flood forecasting, and expect Korea-side continue improving and perfecting the System and keep the interesting Members updated.

22) The HRFCO and KICT committed to continue developing and improving the functions of EFFS, and continue providing the technical support to Members in needed.

AOP3: Guidelines for Extreme Flood Risk Management

23) WGH reviewed and summarized the activities and achievement of the project of Guidelines for Extreme Flood Risk Management since 2012, which will be closed at TC 50th Annual Session.

24) The implementation progresses of this project in 2017 were including:

- The 6th WGH working meeting was held in Seoul in conjunction with the workshop.
- The Guideline for Extreme Flood Risk Management in TC region is published and distributed in this meeting.
- The HRFCO and KICT expressed the appreciation to three pilot countries (Lao P.D.R, Philippines, Thailand) for contribution on drafting the guideline.

25) The Participants reviewed the final version of Guidelines with deep discussion. The participants expressed the appreciation to Dr. Chung-Soo KIM of KICT for his efforts on drafting the Guidelines with abundant information. The Guidelines was printed as one TC publication and distributed at 12th IWS to be held in Jeju, Korea from 30 October to 03 November 2017.

AOP4: Development Operational System for Urban Flood Forecasting and Inundation Mapping (OSUFFIM) for Selected TC Members

26) WGH reviewed the implementation progresses of OSUFFIM in 2017. The main activities conducted for OSUFFIM in 2017 were briefed as:

- Application in Dong Guan City of China;
- DID Malaysia visiting SYS University with fund support from SYS University;

- Software updating and perfecting for Pilot City of Thailand;
- Survey Mission in Malaysia from 24 to 31 August 2017;
- RID experts visiting SYS university from 20 to 22 October 2017 for discussion the structure of OSUFFIM to be applied in Thailand.
- Survey Mission in Vietnam from 13 to 19 November 2017;
- OSUFFIM workshop was held in SYS University Guangzhou, China from 27 to 30 December 2017, with participants from China, Myanmar, Malaysia, Philippines, Thailand and Vietnam as well as TCS;
- Organized the planed Workshop on 28-30 November 2017 in Guangzhou, China.
  - The Participants include the heads of divisions or senior experts from TC Members: Thailand (2), Philippines (2), Malaysia (1), Viet Nam (1) and Lao PDR(1), and PTC Members: Myanmar(1); and the hydrologist of TCS, Dr. Jinping LIU;
  - For the participants from TC Members, TCTF funded international transportation and partial DSA; SYS University funded accommodation; and for the participants from PTC Members, SYS funded all expenses.
  - TCS distributed the Nomination Form right after 6th WGH working meeting.
- Prof. CHEN Yangbo of SYS University and TCS Hydrologist Mr. LIU Jinping visited Ho Chi Ming, Hue and Hanoi of Vietnam from 13 to18 November 2017 for selecting the pilot city from 2-3 surveyed cities. The National Center for Hydro-Meteorological Forecasting (NCHMF), National Hydro-Meteorological Service (NHMS) of Viet Nam provided very strong support to the survey mission. The focal point of Viet Nam Ms. DANG Thanh Mai coordinated this event.
- SYS University expert visiting Hat Yai of Thailand for Data collection from 29 January to 3 February 2018.

27) Considering there are many things not yet fulfilled on OSUFFIM and some Members expressed their willingness to apply OSUFFIM, SYS University planned to conduct Phase-II for OSUFFIM as one of WGH AOPs from 2018 to 2020. The pilot cities will be selected from above-mentioned Members. The roadmap of OSUFFIM-II was proposed as below:

- 2018: updating operation system for Hat Yai of Thailand; study the urban flood pattern in TC Members; system development preparatory for selected new pilot cities in 2 or 3 interested Members; and technical publication.
- 2019: modeling system construction and development, and trial operation
- 2020: continual trial operation; summarize the project.

28) The implementation plan was discussed for 2018:

- to end of March: decide 2 or 3 new pilot cities.
- to September (13th IWS): maintain the operation system in Hat Yai city of Thailand and Dong Guang city of China; field survey, data collection and study urbanization pattern in selected new pilot cities;
- to end of December: conduct kick-off meeting for discussing work plan; summarize the operation in Thailand and China.

IV. New Proposals for 2018 and Beyond

29) Following the decision made at TC 49th Session, Korea proposed two new AOPs, and China proposed one new AOP for 2018 and beyond.

New Proposal 1: Application of Hydrological Data Quality Control System in TC Members

30) Acquirement of the high quality hydrological data is the most basic work in flood forecasting. But, there is no hydrological data quality control system in TC member countries. The project will be support and provide the guideline and system to upgrade the quality of hydrological data in TC regions.

31) The project will be drove by HRFCO of Korea with support of KICT and last 5 years from 2018 to 2022, with objects of:

- enhancement of TC Member's capacity for managing & monitoring of hydrological data (Rainfall, Water Level, Discharge);
- reducing the uncertainty of input data for flood forecasting;
- suggesting the procedure of producing hydrological data; and
- establishment of the hydrological data quality control system linkage to EFFS

32) The basic methodology of data processing and quality control to be applied in the project can be briefed as:

- Rainfall : arithmetic mean, RDS weighted average, Kriging method, etc.
- Water Level : arithmetic mean, relationship with upper-down stream station, Neural Network, etc.
- Discharge : calculation of uncertainty in measuring the discharge, assessment of stage-discharge relationship equation, etc.

33) The roadmap of the project are described as:

- 2018: Analysis of the status for Monitoring Hydrological Data in TC regions
- 2019: Suggestion of the Establishment Direction & Techniques
- 2020: Development of Hydrological Data Quality Control System (1)
- 2021: Development of Hydrological Data Quality Control System (2)
- 2022: Distribution of the System & Publication, Training

34) The implementation plan for 2018 was proposed as below:

- Analyze the status of hydrological data monitoring and management in TC members
- Exchange & confirm the results of analysis
- Survey the Hydrological Data Quality Control System in Republic of Korea

35) Some participants expressed their interests to join this project and will provide further commitment for this AOP, such as HFC of China, DID Malaysia and etc.

New Proposal 2: Enhancement of Flood Forecasting Reliability with Radar Rainfall Data and Stochastic Technique

36) It is necessary to upgrade the developed EFFS, especially flood forecasting technology using radar data. In addition to the deterministic flood forecasting, probabilistic flood forecasting technology should be applied to provide more informative information to the public.

37) The project will be drove by HRFCO of Korea with support of KICT and last 5 years from 2018 to 2022, with objects of:

- Enhance TC Member's capacity for flood forecasting using radar rainfall data & stochastic techniques
- Provide the various input data for flood forecasting
- Upgrade the LEVEL3 module of EFFS
- Evaluate the uncertainty of flood forecasting
- Suggest the procedure of stochastic flood forecasting

38) The basic methodology of enhancing the flood forecasting reliability to be applied in the project can be briefed as:

- Flash flood guidance
- Ensemble forecasting with rainfall & discharge scenario
- Pre-, Post processing method in ensemble forecasting

39) The roadmap of the project are described as:

- 2018: Analysis of the Status for using Radar Rainfall Data in TC regions
- 2019: Suggestion of the Establishment Direction & Techniques
- 2020: Modify the LEVEL 3 of EFFS
- 2021: Produce the Rainfall Ensemble in TC Members
- 2022: Development of Stochastic Flood Forecasting System

40) The implementation plan for 2018 was proposed as below:

- Analyze the status of flood forecasting with radar rainfall data in TC members
- Exchange & confirm the results of analysis
- Survey the flood forecasting with radar rainfall data in Republic of Korea

New Proposal 3: Impact Assessment of Climate Change on Water Resource Variability in TC Members

41) Climate change has currently been an utmost important environmental issue, which will challenge the existing water resources management practice in many ways. Climate change and its increased variability is expected to alter timing and magnitude of runoff, and consequently has significant implication for the existing water resources system as well as for future water resources planning and management. Quantitative assessment of water resources in the context of climate change is essential to sustainable water resources utilization. Suitable hydrological models have been believed a powerful toll in water resources assessment. During the past years, the Research Center for Climate Change of Ministry of Water Resources, China devoted great efforts to develop a monthly Water Balance Model namely RCCC-WBM model for regional water resources purpose by full considering complex environment changes (i.e. climate change, human activities). The model has been widely applied to major rivers across whole China, and exhibits a broad suitability.

42) The project will be drove from 2018 to 2020 by Water Information Center (WIC) of the Ministry of Water Resource (MWR) with support from Nanjing Hydraulic Research Institute (NHRI). The project was proposed with following object, target and output:

- Objective: the proposal is to collect, collate, analyst, evaluate and develop the water resources modelling information for better decision management system so that to improve the capacity building among TC Members on better understanding water modelling and water resources management.

- Target: extension of the RCCC-WBM model by job training with TC expert on water resources modelling and decision-making process.
- Output: providing the sustainable water resources information for water resources manager decision making process.

43) The basic methodology of data processing and quality control to be applied in the project can be briefed as two steps: (1) collect the catchment average precipitation, temperature, pam evaporation, and discharge gauged at outlet hydrometric station; and (2) apply the RCCC-WBM model in target rivers or basins to simulate the changing trend of water resources in the context of the climate change.

44) To achieve the objective, there are two approaches for implementation of the project:

- Apply RCCC-WBM to wide catchment for water resources study assessment, improve Members' capacity by having several training courses, and provide scientific supports for sustainable utilization of water resources of target catchments.
- Test suitability of RCCC-WBM to target catchments, organize 2-3 training workshops to train technicians of target Members, and apply RCCC-WBM to typical catchments of interested Members.

45) The roadmap of the project are described as:

- 2018: Collect hydro-meteorological data and general information of typical catchment with the supports from target countries, analyze hydrological features of these catchments, test performance of RCCC-WBM model, prepare training materials of RCCC-WBM model and organize the first workshop.
- 2019: Prepare training materials of RCCC-WBM model, organize the second workshop and help the trainees to apply the model to target catchments for hydrological modeling and water resources assessment
- 2020: Organize the third workshop, summarize the application results, and report to IWS.

46) The implementation plan for 2018 was proposed as below:

- to select pilot areas in China and participating Members;
- to collect hydro-meteorological data and general information of typical catchment with the supports from target countries;
- to analyze hydrological features of selected catchments, test performance of RCCC-WBM model;
- to prepare training materials of RCCC-WBM model; and
- to organize the first seminar.

47) Some participants expressed their interests to join this project and will provide further commitment for this AOP, such as DID Malaysia, Meteorological and Hydrological Department (MHD) of Laos, and etc.

48) The WGH AOPs for 2018 and beyond were summarized in Table 2.

Table 2 The summary of WGH AOPs in 2018 and beyond

Item	Projects	Driver	Duration
AOP1	Flash Flood Risk Information for Local Resilience	Japan	2017~2019

AOP2	Application of Hydrological Data Quality Control System in TC Members	Korea	2018-2022
AOP3	Enhancement of Flood Forecasting Reliability with Radar Rainfall Data and Stochastic Technique	Korea	2018-2022
AOP4	OSUFFIM Phase-II: Extension of OSUFFIM Application in TC Members	China	2018~2020
AOP5	Impact Assessment of Climate Change on Water Resource Variability in TC Members	China	2018~2020

V. Selection of WGH Chairperson

49) Following the decision of TC 49th Session (stated in paragraph 69: The Session noted that, WGH does not yet get consensus on its Chairperson selection, and agreed to coordinate and select its new chairperson and vice chairperson at 6th WGH meeting based on further communication among hydrological components of Members for the term of next two years to 51st Annual Session. Mr. Yoshio Tokunaga from ICHARM of Japan and Dr. CHO Hyo Seob from HRFCO of the Republic of Korea are requested to continue working as Chairperson and vice chairperson of WGH, respectively, until the selection), the meeting coordinated and selected WGH new chairperson and vice chairperson.

50) The participants got consensus on WGH chairperson selection: to request Mr. Yoshio Tokunaga from ICHARM of Japan and Dr. CHO Hyo Seob from HRFCO of the Republic of Korea continue working as Chairperson and vice chairperson of WGH, respectively, to TC 51st Annual Session. Dr. HOU Aizhong from BOH of China continues serving as Vice-chairpersons of WGH to 51st Annual Session.

51) Based on deep discussion at TC 12th IWS WGH parallel session, WGH requested AWG to discuss and consider the possibility of Chair/Co-Chair system for WGH, which was accepted mostly and proposed by WGH, in a small group, and advise TC 51st Session for final decision. WGH will be obligated to follow the decision.

VI. Review TCTF allocation for WGH activities in 2017 and Proposal for 2018

52) WGH reviewed the usage of the allocated budget of TCTF for WGH activities in 2017 shown in table 3.

Table 3 The summary of budget of TCTF to support WGH activities in 2017

Item	AOP	TCTF(USD)
1	Support to attend Integrated Workshop (IWS) and other activities	10,000
2	Support publishing the two technical reports of AOP2 and AOP6	5,000
3	Support activities related to OSUFFIM	6,000
4	Support hosting AOP 6 seminar with hosting 6th WGH working meeting	3,000
	Total	24,000
	Special budget for supporting OSUFFIM Final workshop	$6000

53) Based on the discussion, WGH proposed the budget request for its activities in 2018, shown in table 4.

Table 4 The summary of TCTF Budget Request for 2018 Activities

Item	Projects	Driver	Budget
1	Support to attend Integrated Workshop (IWS) and other activities		10,000
2	Support AOP1: Flash Flood Risk Information for Local Resilience including hosting 7th WGH working meeting in Japan	Japan	5000
3	Support AOP4: OSUFFIM Phase-II: Extension of OSUFFIM Application in TC Members	China	6000
4	Support AOP5: Impact Assessment of Climate Change on Water Resource Availability in TC Members	China	4000
	Total		**25,000**
	Special Request for OSFFIM Technical Report Publication	China	3000

VII. Conclusion of WGH

54) On the basis of the outcomes 6th WGH working meeting and the discussion of the WGH Parallel Session at 12th IWS, the following conclusions were reached:

- The working meeting of WGH is very important to review hydrological activities, deep technical discussion and implementation status of WGH AOPs, and also is very necessary to prepare IWS and annual session. The funding support and contribution from the Republic of Korea played the vital role in organizing the annual working meeting in past years. WGH encourages the more and wider resources to support the activities to keep its sustainability.
- To promote the capacity of forecasting, early warning and risk management for urban flood is an urgent need among TC Members, especially urban flood forecasting and inundation mapping. As the subsequent activity of TC first Cross-cutting project of Urban Flood Risk Management (UFRM), the on-going project of WGH on Development and Application of Operational System for Urban Flood Forecasting and Inundation Mapping (OSUFFIM) is a tangible measure on this aspect and it will play very meaningful and important role for TC Members to promote the capacity on the technique of urban flood forecasting and warning.
- Acquirement of the high quality hydrological data is the most basic work in flood forecasting. At present, there is no hydrological data quality control system running well in TC Member countries. In order to improve the hydro-meteorological data quality control so that to promote the capacity of flood forecasting and warning in TC Members, it is very meaningful to develop an operational system for data quality control sharing among Members.
- In TC Members, water is considered as the core of sustainable development and a critical element for its socio-economic development. Water is the driver of the key sectors of its economy and will remain as a crucial element to sustain its healthy ecosystem which eventually affects the well-being of its population. Water is a finite resource and it is only renewable if well managed. Water can pose serious

challenges to sustainable development but if managed efficiently and equitably, water would play a key enabling role in strengthening the resilience of social, economic and environmental systems in the light of rapid and unpredictable changes. Therefore, one of the key elements in managing water resources is to provide a comprehensive management instrument which could provide multiple functions including accounting for water resources, providing real time via on-line information and long term (projection) on water availability and variability, an assessment tool to evaluate operation options for efficient water allocation and a forecasting system to assist in the decision making process. It is necessary and important for WGH to conduct the cooperation on Impact Assessment of Climate Change on Water Resource Variability among TC Members for implementation of KRA 3 of Strategic Plan 2017-2021.

- 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.

VIII. Recommendations of WGH

55) On the basis of the outcomes 6th WGH workshop & meeting and the discussion of the Parallel Session of 12th IWS, the participants concurred to make the following recommendations to the TC 50th Session to be held in Hanoi from 28 Feb. to 03 March 2018:

- to appoint Mr. Yoshio TOKINAGA from ICHARM of Japan as Chairperson of WGH; Dr. CHO Hyo Seob from HRFCO of the Republic of Korea and Dr. HOU Aizhong from HFC of China as vice chairperson of WGH, to TC 51st Annual Session.
- to request AWG to advise on the matter of Chairmanship for WGH. Before that WGH will follow its current TERMS OF REFERENCE in a consultative and harmonized manner.
- to request US$10,000 from TCTF in total for supporting WGH members participating TC 13th IWS.
- to request US$15,000 from TCTF in total for supporting overall WGH activities for 2018 calendar year.
- to request US$3,000 special budget to support publishing OSUFFIM technical report in 2018;
- To request MLIT and ICHARM of Japan to host WGH 7th working meeting with funding support in September 2018.
- to approve the proposal to conduct phase II for OSUFFIM as a continual project in a period from 2018 to 2020;
- to approve the initiatives of two AOPs in the period from 2018 and 2022 proposed by HRFCO of the Republic of Korea: (1) Application of Hydrological Data Quality Control System in TC Members; and (2) Enhancement of Flood Forecasting Reliability with Radar Rainfall Data and Stochastic Technique.
- to approve the project in the period from 2018 and 2020 proposed by HFC of MWR and NHRI of China: Impact Assessment of Climate Change on Water Resource Variability in TC Members.

- to request HRFCO to continue maintaining and operating the WGH webpage for effective sharing information among WGH members with support from KICT and TCS.
- to re-appoint the focal point of WGH, Ms. Ji-Youn SUNG, HRFCO of the Republic of Korea as the liaison to WGH of WMO RA II for WGH of the Committee.
- to continue focusing on improving the ability to forecast hydrological phenomena and provide measures for the effectiveness of the improvements.

Annex 1. Implementation Status of WGH AOP 2017

Annex 2. Successor Indicators of WGH AOP 2018

Annex 1. Implementation Status of WGH AOP 2017

SP's KRA and SG	Objective Number	Objective	Action	Other WGs Involved	TCS Responsibility	Expected Quarter Completed	Other Organizations Involved	Success Indicators	Funding Required	Funding Sources	Completed YES/NO
KRA 1 SG 1 KRA 2 SG 2 KRA 4 SG 4a KRA 6 SG 6b	1	Flash Flood Risk Information for Local Resilience	to develop a guidance tool for enhancing local resilience to flash flood disaster risks and disseminate it among the WGH member countries.	WGDRR (TBD)	Coordination	(a) First (b) Second (c) Third (d) Fourth	PAGASA of Philippines(TBD)	(a) Technical Presentation (b-d)Case Study in Japan and needs assessment		ICHARM, MLIT	YES YES
KRA1 KRA 4 SG 4a SG 4bKRA5 SG 5a KRA 6 SG 6b	2	Extreme flood forecasting system	To complete the development of extreme flood forecasting system with PC-version and publish the technical report including the theoretical background and system manual. To operate the TC WGH homepage.		See above	(a) First (b) Second (c) Third (d) Fourth	RID of Thailand, PAGASA of Philippines DMH of Laos	(a,b,c) To complete the development of extreme flood forecast system with PC-version (c,d) To publish the technical report (a, b, c, d) To operate the TC WGH homepage	$2500	MOLIT	YES YES YES
KRA 1 SG 1 KRA 2 SG 2 KRA 4 SG 4a KRA 6 SG 6b	3	Guidelines for extreme flood risk management in TC region	To hold the 6th WGH meeting in the R.O.K To publish the guideline for extreme flood risk management including the field survey report.		See above	(a) First (b) Second (c) Third (d) Fourth	RID of Thailand, PAGASA of Philippines DMH of Laos	(b,c) To prepare and host the 6th WGH working meeting (a, b, c) To publish the guideline for extreme flood risk management	$2500 Plus $3000	MOLIT,	YES YES
KRA 1 SG 1 KRA 2 SG 2 KRA 4 SG 4a KRA 6 SG 6b	4	OSUFFIM system development and trial operation	1. Development of OSUFFIM operational system; 2. Trial operation of OSUFFIM operational system in pilot cities; 3. compile the user guideline both in Chinese and English 4. have a workshop to distribute the outcomes of OSUFFIM; 5. start 1-2 new pilot cites in TC members		See above	(a) First (b) Second (c) Third (d) Fourth	Dongguan Flood Management Office RID of Thailand, PAGASA of Philippines	(a,b,c) Complete the development of OSUFFIM operational system (a,b,c) Trial operation of OSUFFIM in Chinese and Thailand (d) publish user guideline in English; (d)Final workshop (d) Field investigation to 1-2 new cites in Members	$6, 000 + Special $6000 for supporting the final workshop	SYS Uni. RID, PAGASA. DID, NMHS, DMH TCTF	YES On-going On-going Yes Yes

Annex 2. Successor Indicators of WGH AOP 2018

KRA	Objective Number	Objective	Action	Other WGs Involved	TCS Responsibility	Expected Quarter Completed	Other Organizations Involved	Success Indicators	Funding Required	Funding Sources
KRA 2 KRA 3 KRA 4	1	Flash Flood Risk Information for Local Resilience	To develop a guidance tool for enhancing local resilience to flash flood disaster risks and disseminate it among the WGH member countries.	WGDRR (TBD)	Coordination	(a) First (b) Second (c) Third (d) Fourth	PAGASA of Philippines (TBD)	(a.b) To prepare an interim report on actual disaster experiences and cases of good practice in English (b.c.d) To introduce IFI platform and survey potential site in WGH Member (c.d) To hold one-day workshop in conjunction with WGH 7th working meeting in Japan and make its report	5,000	ICHARM, MLIT
KRA2 KRA3 KRA4	2	Application of Hydrological Data Quality Control System in TC Members	To analyses the status of data quality control in TC Members		See above	(a) First (b) Second (c) Third (d) Fourth		(a)(b)(c) Analyze the status of hydrological data monitoring and management in TC members (d) Exchange & confirm the results of analysis (c)(d) Survey the Hydrological Data Quality Control System in Republic of Korea		MOLIT
KRA2 KRA3 KRA4	3	Enhancement of Flood Forecasting Reliability with Radar Rainfall Data and Stochastic Technique	To analyses the status of radar data application in flood forecasting in TC Members		See above	(a) First (b) Second (c) Third (d) Fourth		(a)(b)(c) Analyze the status of flood forecasting with radar rainfall data in TC members (d) Exchange & confirm the results of analysis (c)(d) Survey the Hydrological Data Quality Control System in Republic of Korea		MOLIT,
KRA2 KRA3 KRA4	4	OSUFFIM phase-II: extension of Application of OSUFFIM	to extend the application of OSUFFIM in selected Members		See above	(a) First (b) Second (c) Third (d) Fourth		(a) select 2 or 3 new pilot cities. (b)-(c) maintain the operation system in Hat Yai city of Thailand and Dong Guang city of China; field survey, data collection and study urbanization pattern in selected new pilot cities; (d) conduct kick-off meeting for discussing work plan; summarize the operation in Thailand and China; Publication.	6000 + 3000 special request	HFC; SYS Uni. China

KRA	Objective Number	Objective	Action	Other WGs Involved	TCS Responsibility	Expected Quarter Completed	Other Organizations Involved	Success Indicators	Funding Required	Funding Sources
KRA3	5	Impact Assessment of Climate Change on Water Resource Variability in TC Members	To selected pilot catchments and to prepare training materials of RCCC-WBM model		See above	(a) First (b) Second (c) Third (d) Fourth		(a)-(b)to select pilot areas in China and participating Members; (b)-(c)to collect hydro-meteorological data and general information of typical catchment with the supports from target countries; (c)-(d)to analyze hydrological features of selected catchments, test performance of RCCC-WBM model; prepare training materials of RCCC-WBM model; and (d) to organize the first seminar.	4000	HFC; NHRI, China

- KRA 1: Enhance capacity to monitor mortality and direct economic loss caused by typhoon-related disasters.
- KRA 2: Enhance capacity to generate and provide accurate, timely and understandable information using multi-hazard impact-based forecasts and risk-based warnings.
- KRA 3: Improve typhoon-related flood control and integrated water resource management.
- KRA 4: Strengthen typhoon-related disaster risk reduction activities in various sectors, including increased community-based resiliency with better response, communication, and information sharing capability.
- KRA 5: Enhance Typhoon Committee's Regional and International collaboration mechanism.