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ENGLISH ONLY

Report on Activities of Working Group on Hydrology (WGH) of TC in 2022

(Item 8 of Tentative Program for TC 55th Session)

(Submitted by WGH)

ACTION REQUIRED:

This Committee is invited to:

- a) Review the activities of TC WGH conducted in 2022
- b) Approve the recommendations and AOPs of WGH for 2023 and beyond

APPENDIXES:

- I. DRAFT TEXT FOR INCLUSION AT SESSION REPORT
- II. Report on activities of Working Group on Hydrology (WGH) of TC in 2022

APPENDIX I

DRAFT TEXT FOR INCLUSION AT SESSION REPORT

9.2 Hydrological Component

1. The Committee reviewed the activities of the Members related to the implementation of the decision of TC 55th Session 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 the flood-related disasters happened in 2022 and hydrological activities conducted in Members in the year, and also noted the special measures took in Members for flood disaster risk reduction and the progresses achieved in Members under the situation of COVID-19.
3. The Session noted with pleasure that, the video conference (VC) for 11th working meeting of Working Group on Hydrology (WGH) was organized by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) in cooperation with Infrastructure Development Institute (IDI) and International Centre for Water Hazard and Risk Management (ICHARM) of Japan on 18-19 October 2022. The VC was attended by more than 40 participants from 11 of 14 Members of the Typhoon Committee, namely: China; Hong Kong, China; Japan; Lao People's Democratic Republic (Lao PDR); Malaysia; the Philippines; Republic of Korea; Singapore; Thailand; USA and Viet Nam. Among them 15 participants from Japan, Lao PDR, Malaysia, Philippines and Thailand took part in the face-to-face meeting at the MLIT headquarters. Typhoon Committee Secretariat (TCS) and Thai Meteorological Department (TMD) of Thailand also participated in the VC. The Session expressed its appreciation to the Japan government through MLIT with cooperation of ICHARM and IDI of Japan for generously hosting the meeting.
4. The Session was noted that WGH encouraged all Members to consider undertaking the hosting of the WGH annual working meeting. The Session also was informed with appreciation that MLIT of Japan is planning to jointly host WGH 12th working meeting with RID of Thailand with funding support in Bangkok, Thailand.
5. Following the decisions made at TC 54th Session, WGH tried its best to conduct the activities for implementing its following 7 AOPs in 2022 including domestic research, paper works and virtual meetings:
 - a) AOP1: Knowledge Sharing on Storm Surge Inundation Mapping
 - b) AOP2: Application of Hydrological Data Quality Control System in TC Members

- c) AOP3: Enhancement of Flood Forecasting Reliability with Radar Rainfall Data and Stochastic Technique
 - d) AOP4: OSUFFIM Phase-II—Extension of OSUFFIM Application in TC Members
 - e) AOP5: Impact Assessment of Climate Change on Water Resource Variability in TC Members
 - f) AOP6: Flood Risk Watch Project for Life-saving
 - g) AOP7: Platform on Water Resilience and Disaster under IFI
6. The Session was informed that the project of “Knowledge Sharing on Storm Surge Inundation Mapping” (AOP1) led by Guam of USA has not yet been started the piloting study in Members fundamentally. WFO Guan is currently soliciting interested Members, and then a copy of the program POSSIM will be provided to the interested Members as well as the training on use and update of bathymetry data will be conducted in 2023 and beyond. The Session also noted with pleasure that, up to November 2022, China, Republic of Korea and Thailand expressed their interest in taking part in this project.
7. The Session noted that, the project on Application of Hydrological Data Quality Control System in TC Members (AOP2) and the project on Enhancement of Flood Forecasting Reliability with Radar Rainfall Data and Stochastic Technique (AOP3), led by Han River Flood Control Office (HRFCO) of the Republic of Korea in cooperation with Korea Institute of Civil Engineering and Building Technology (KICT) conducted following activities including: (1) organized a joint virtual seminar on November 18, 2022 for to introduce the development status on the system, demonstrate the system operation, and listen to Members’ needs for future system improvement. The workshop was attended by 12 participants from Republic of Korea, Lao PDR, Philippines Thailand as well as TCS; (2) finalized the establishment of the hydrological data quality control system (PC-version). and the stochastic flood forecasting system; (3) drafted the user manuals for two Systems, which will be printed after TC 55th Session in 2023. The Session was informed that two projects will be closed at TC 55th Session and expressed its gratitude to HRFCO and KICT of Republic of Korea as well as all participating Members for their contribution and cooperation during past 5 years to make two AOPs successful.
8. The Session noted that, the pilot study of Liuxihe Model for the phase-II of the project on Development and Application of Operational System for Urban Flood Forecasting and Inundation Mapping (OSUFFIM-II) for TC Members (AOP4) was continually conducted in China, Malaysia and Philippines with the satisfactory results in 2022. The Session also informed the following activities will be conducted in 2023: (1) improving parameter optimization for the pilot studies in Malaysia, Philippines, and China; (2) conducting trial operation of real-time flood forecasting of the pilot studies in Malaysia, Philippines, Vietnam, and China; (3) organizing project workshop, online or face-to-face (TBD); and (4) final conclusion.

9. The Session was informed with pleasure that, China-side got following achievement on the project on Impact Assessment of Climate Change on Water Resource Variability in TC Members (AOP5) in 2022: (1) the RCCC-WBM model was improved by adding flow duration curve module and software was registered; (2) 25 catchments with different hydro-meteorological characteristics were selected. The improved model was applied to these catchments. The simulation for low flow was well improved by considering flow duration curve; and (3) the Technical Report of “RCCC model and its application for Impact Assessment of Climate Change on Water Resource Variability” was published as TC publication (TC/TD-No. 0023). The scheduled activities for 2023 includes: (1) to organize face to face training workshops in selected TC Members focusing on data acquisition and evaluation, and model calibration and application; (2) to extend RCCC-WBM model application in interested TC Members for assessing climate change impact, and exchange experiences and lessons of model application; and (3) to provide guidance on case studies of typical catchments in interested TC members by using the RCCC-WBM model and understanding practical situation of catchments for supporting climate change adaptation and water resources management.
10. The Session was informed that, the schedule activities for the project on Flood Risk Watch Project for Life-saving (AOP6) in 2022 were implemented in Malaysia, including: (1) MLIT recruited water level gauge (WLG) manufacturers to participate in the 3L WLG test installation plan, and four companies decided to participate in the test installation; (2) Malaysia and Japan have resumed concrete activities to start 3L WLG installation and test observations in the first half of 2022; (3) WLG manufacturers participating in the test construction have developed 3L WLGs that meet Malaysian specifications; (4) all WLG manufacturers brought their 3L WLGs to Malaysia and installed them in the test site. And (5) all companies started test observations in late July 2022. The Session also informed that, in 2023, MLIT of Japan will continue make adjustment of observation accuracy, status of data transfer to the server, and evaluation of observation accuracy according to the specific requirements. The implementation will be completed in April 2023, and MLIT of Japan will share the results of the test observations of 3L WLG in Malaysia with other TC Member.
11. The Session was informed that, in 2022, ICHARM of Japan conducted following activities for the Project of Platform on Water Resilience and Disasters under IFI (International Flood Initiative) (AOP7), including: (1) the hands-on training was conducted for Davao City in the Philippines by remotely gathering 31 participants from different disciplines and sectors of local society; and (2) Online Synthesis System for Sustainability and Resilience (OSS-SR) has been updated to upload local knowledge and status. The Session noted with appreciation the project will be officially closed at TC 55th Session, and expressed its appreciation to ICHARM of Japan for its contribution to this cooperation project.
12. The Session was informed with pleasure that, 5 new projects were proposed from Members to be officially launched at TC 55th Annual Session as WGH new AOPs in 2023 and beyond, including:
 - Improvement of Hydrological Data Quality Control System by Using AI technology
 - Improvement of Flood Forecasting modelling by Using AI technology

- Flood resilience enhancement through Platform on Water Resilience and Disasters
 - Training Course on Hydrological Monitoring and Flood Management for Developing Countries
 - Synergized Standard Operating Procedures for Coastal Multi-Hazard Early Warning System (SSOP)-Phase III
13. The Session was informed that, the project on Improvement of Hydrological Data Quality Control System by Using AI technology with 5 years period from 2023 to 2027, proposed by HRFCO in cooperation with KICT, will be launched officially at TC 55th Session as WGH new AOP2. The following activities/implementation plan for the project in 2023 are described as: (1) to conduct application and practical testing in 4 pilot target TC Members (Malaysia, Lao P.D.R, Philippines, Thailand); (2) to conduct requirement analysis and gathering the opinions and comments from TC Members; and (3) to update and modify the hydrological quality control system and select the new technique for system upgrading
 14. The Session was informed that, the project on Improvement of Flood Forecasting modelling by Using AI technology with 5 years period from 2023 to 2027, proposed by HRFCO in cooperation with KICT, will be launched officially at TC 55th Session as WGH new AOP3. The following activities/implementation plan for the project in 2023 are described as: (1) to conduct the application and practical testing in TC Members; (2) to conduct requirement analysis and gathering the opinions and comments from TC Members; and (3) to establish the modification plan of the Extreme Flood Forecasting System (EFFS) and select the upgrade item for operating system.
 15. The Session was informed that, the project on Flood resilience enhancement through Platform on Water Resilience and Disasters with 5 years period from 2023 to 2027, proposed by ICHARM of Japan, will be launched officially at TC 55th Session as WGH new AOP7. The following activities/implementation plan for the project in 2023 are described as: (1) to develop and improve OSS-SR which will integrate knowledge, technology, know-how, and experience of different disciplines related to flood disasters; (2) to conduct capacity development to foster local Facilitators utilizing OSS-SR as an E-learning tool; (3) to cooperate with Facilitators for disseminating scientific knowledge and technology to local stakeholders relevant to water-related disaster management; and (4) to cooperate to implement the activities above with other working groups of the Typhoon Committee.
 16. The Session was reformed that, the Training Course on Hydrological Monitoring and Flood Management for Developing Countries organized by the Ministry of Water Resources, China is a long-term annual training programme for developing countries covering most TC and PTC Members. To combine this annual training course with TC WGH activities as one of AOPs can benefit TC Members from the training programme including facilitates, expertise and funding resources in future. As requested from Members, China agreed to officially launch the Training Course on Hydrological Monitoring and Flood Management for Developing Countries at TC 55th Session as WGH AOP8 at TC 55th Session. This AOP

will be executed in the period of 3 years from 2023 to 2025. A two-week training course will be held annually with funding support from China government in forms of video, hybrid or face-to-face, depending on the situation of the COVID-19.

17. The Session was noted that, WGH recognized the phase-III of Synergized Standard Operating Procedures for Coastal Multi-Hazard Early Warning System (SSOP-III) is a meaningful proposal to TC Members, and agreed to set SSOP-III as WGH AOP9 with 3 years period from 2023 to 2025. The Session was informed with pleasure that USA would like to play the role as the driver of SSOP-III, and WGH AOPs' leaders expressed their willingness to combine their activities (such as training, missions) and research results with SSOP-III activities.
18. The Session was informed that, the project of Knowledge Sharing on the Southeast Asia Flash Flood Guidance System (SeAFFGS), which was proposed at TC 54th Session, is not yet ready to officially launch at TC 55th Annual Session as one WGH AOP in 2023 and beyond. The Session also recognized that, the flash flood is a common severe challenge in TC Members. To share the knowledge of the flash flood guidance among Members is very important on promotion of the capacity of flash flood related disaster prediction and early warning. MHA of Vietnam has initialed a very good project on the Southeast Asia Flash Flood Guidance System (SeAFFGS) which will definitely benefit all TC Members. The Session requested MHA of Vietnam to continue considering the possibility of officially launching this project as WGH AOP when it is ready to do so.
19. The Session was informed that, considering the changed security policy in the Republic of Korea since 2017, the strategy of maintaining and operating the WGH web-page should be changed and advised to be integrated with TC web-page for an effective maintenance and easy accessibility. The Session expressed its appreciation to HRFECO with cooperation of KICT for their maintaining and operating the WGH web-page in the past years.
20. The Session was informed that, Dr. Mamoru Miyamoto from Japan was selected continuing serving as WGH Chairperson, Dr. CHO Hyo Seob from Republic of Korea, Dr. HOU Aizhong from China, and Mr. Kenneth KLEESCHULTE from USA continuing serving as Vice-chairpersons for next two years. The Session expressed its gratitude for their hard work and contribution in the past two-year term.
21. The Session was noted with pleasure that, as the situation of COVID-19 epidemic improves, WGH plans to enhance the cooperation with RAII Coordination Panel on Hydrology and Water Resources (CPH, former RAII Working Group on Hydrological Services) under the coordination of TC WGH vice chairperson Dr. Hyo-Seob CHO as the Chair of the WMO RAII CPH. The Session also noted with gratitude that Dr. Hwirin Kim, Head of Hydrological and Water Resources Services Division (HWR) of WMO, had a very positive response on making a synergy between TC WGH and RAII CPH.

CONCLUSIONS OF WGH

22. On the basis of the discussion and outcomes at 11th WGH working meeting and the parallel session of TC 17th IWS, participants recognized the importance in following aspects for further direction of WGH:
- WGH 11th working meeting was held in hybrid way. Partial participants from 5 Members joined the face-to-face meeting in Tokyo, Japan. To a certain extent it made the meeting a better effectiveness and efficient, especially to the sessions of technical discussion. Face-to-face meeting should be encouraged as far as possible in future if the condition of COVID-19 allows to do so.
 - Due to climate change and urbanization, extreme hydro-meteorological events happened more frequently in past decades, especially the flash flood and landslides caused by local heavy rainstorm has become a major disaster risk, and its forecasting and warning rises big challenge in Asia and Pacific region. Every year huge economic damage and life losses caused by flash flood and landslides in TC Members. WMO Secretariat and National Meteorological and Hydrological services (NMHSs) have paid close attention and made great efforts on promoting the capacity of flash flood disaster forecasting and early warning. WMO has agreed to deliver Vietnam National Meteorological and Hydrological Administration (VNMHA) as a Regional Center for developing and implementing the SouthEast Asian Flash Flood Guidance System (SeAFFGS), and the project on SeAFFGS was launched officially in Ha Noi, Viet Nam on 28 June 2022. To share the knowledge of flash flood guidance among Members, MHA of Vietnam was encouraged to officially launch this project as WGH AOP when it is ready to do so.
 - SSOP phase-I focused on analyzing status and summarizing the knowledge of operating procedures for coastal multi-hazard early warning system. SSOP phase-II focused on training and sharing the synergized knowledge on standard operating procedures (SOP) achieved from phase-I. SSOP-III is proposed to practice the knowledge of SSOP in operating procedures for coastal multi-hazard early warning, and will focus on the last mile at the local level. The proposed practice of SSOP will make Members know intimately the SOP for coastal multi-hazard early warning, consequently promote the capacity of coastal multi-hazard disaster risk reduction. As a very important link to coastal multi-hazard early warning and disaster risk reduction, hydrological component should be closely involved in the proposed SSOP phase-III.
 - It is recognized that training is a very effective and important measure for TC Members to improve the capacity of their professional staff. In past years, WGH conducted a series of activities related to training courses and workshops including on-job training and achieved good results. In 2021, Nanjing Research Institute of Hydrology and Water Conservation Automation (NIHWA), the Ministry of Water Resources, China set a long-term programme of annual training course on hydrological monitoring and flood management for developing countries, covering some Members of TC and PTC. WGH persuaded of the merits of this programme to TC Members on sharing the resources including facilities, expertise and funding resources. On this connection, combining this long-term annual training programme with TC WGH activities as its one of AOPs should greatly benefit both TC and China.

- Due to the impact of COVID-19 in the past 3 years, the virtual conference became a normal format for WGs' annual meeting and TC integrated workshop (IWS). Due to the time difference and limited agenda, it is very hard for AOP leaders to have enough time for deep technical explanation and discussion at WGs' meetings and TC IWS. To resolve this problem, all AOP leading Members are encouraged to conduct extra workshop or training courses for their AOPs (on-line, hybrid, or face-to-face) with the purpose of deep technical training and discussion for AOP's implementation so as to keep its momentum and sustainability.
- It is a consensus on that, the working meeting of WGH is very important to review and push forward hydrological activities, and is very necessary to prepare IWS and annual session. WGH appreciated the generous contribution from Republic of Korea and Japan in the past years for hosting WGH working meetings. WGH also encouraged more Members to host its working meeting.
- As the situation of COVID-19 epidemic improves, WGH agreed to continue enhancing the cooperation with RA II, PTC and other regions, under the Cooperation Mechanism between TC and PTC, through involving more participants from outside of Typhoon Committee region in WGH working meeting. WGH is willing to make a synergy between TC WGH and RAII CPH (former WGHW) under WMO umbrella.

RECOMMENDATIONS OF WGH

23. On the basis of the deep discussion and communication, participants agreed to submit the following recommendations to the Committee at TC 55th Annual Session:
 - to re-appoint Dr. Mamoru MIYAMOTO from Japan as Chairperson, and to re-appoint Dr. CHO Hyo Seob from Republic of Korea, Dr. HOU Aizhong from China, and Mr. Kenneth KLEESCHULTE from USA to continue serving as Vice-Chairpersons for WGH in next two years.
 - to request US\$25,000 from TCTF for supporting overall WGH activities for 2023 calendar year.
 - to thank Japan for hosting the hybrid conference for WGH 11th Working Meeting on 18-19 October, 2022.
 - to request Japan and Thailand to jointly-host WGH 12th working meeting in Bangkok, Thailand in 2023.
 - to approve the project of "Improvement of Hydrological Data Quality Control System by Using AI technology" from Republic of Korea as WGH AOP2 in the period from 2023 to 2027.
 - to approve the proposal of "Improvement of Flood Forecasting modelling by Using AI technology" from Republic of Korea as WGH AOP3 in the period from 2023 to 2027.
 - to approve the proposal of "Flood resilience enhancement through Platform on Water Resilience and Disasters" from Japan as WGH AOP7 in the period from 2023 to 2027.

- to approve the proposal of “Training Course on Hydrological Monitoring and Flood Management for Developing Countries” from China as WGH AOP8 in the period from 2023 to 2025.
- to approve the proposal of “Synergized Standard Operating Procedures for Coastal Multi-Hazard Early Warning System (SSOP)-Phase III” as WGH AOP9 in the period from 2023 to 2025, and USA plays the role of driver of this AOP.
- to thank HRFCO with cooperation of KICT, Republic of Korea for maintaining and operating the WGH web-page in the past year.
- 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 2022

In 2022, despite the impact of COVID-19, Working Group on Hydrology (WGH) of Typhoon Committee (TC) conducted a series of activities referring to the decision of 54th Session. This report was drafted mainly on the base of the outcomes of 10th WGH working meeting which was hosted virtually by Japan on 18 to 19 October 2022, and the discussion of the parallel session of TC 17th Integrated Workshop (IWS) which was hosted by TCS on 29 to 30 November 2022 via virtual conference.

The report highlighted the main progresses and achievements on hydrological component in Members in past year; briefed the activities of WGH conducted in 2022, and summarized the status of implementation of WGH AOPs 2022. Based on the communication among Members and the discussion at TC 17th IWS, WGH proposed the implementation plan of AOPs for 2023 and beyond; and consequently, requested the TCTF allocation for supporting WGH activities in the year of 2023.

I. Organization of the Video Conference for WGH 11th Working Meeting

1. Referring to the decision of the 54th Session of the ESCAP/WMO Typhoon Committee (TC), the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), Japan hosted the 11th working meeting of TC Working Group on Hydrology (WGH) on 18-19 October 2022.
2. Japan intended to have a face-to-face meeting. Considering the uncertainty protection measures for COVID-19 in Members, the meeting was conducted in a hybrid way. The main meeting on 18th October, 2022 was held at the MLIT headquarters.
3. The proposed theme of the meeting was “Effective Use of Science and Technology towards Building a Resilient Society” with the following purposes:
 - to review and present the status, achievements and progresses in hydrological components of Members in 2022, including recent major initiatives and challenges related to the main theme in Members.
 - to review the implementation and progresses of WGH Annual Operating Plan (AOPs) in 2022;
 - to propose the implementation plan and success indicators for WGH AOPs for 2023, including budget requirement.
4. The working meeting was convened by WGH Chairperson Dr. Mamoru MIYAMOTO, Senior Researcher of the International Centre for Water Hazard and Risk Management (ICHAHM) of Japan.
5. The working meeting was attended by more than 40 participants from 11 out of 14 Members of the Typhoon Committee, namely: China; Hong Kong, China; Japan; Lao People’s Democratic Republic (Lao PDR); Malaysia; the Philippines; Republic of Korea; Singapore; Thailand; USA and Viet Nam. Among them 15 participants from Japan, Lao PDR, Malaysia, Philippines and Thailand took part in the face-to-face meeting at the MLIT headquarters. Typhoon Committee Secretariat (TCS) also participated in the virtual conference (VC).

6. The participants expressed their highest appreciation to Japan government through MLIT in cooperation with IDI and ICHARM of Japan for hosting WGH 11th working meeting.
7. The meeting requested all Members to consider undertaking the hosting of the WGH 12th working meeting in 2023. The representative of MLIT, Japan expressed that, all Members should be encouraged to host WGH annual working meeting, however, Japan-side will accept to host the WGH 12th working meeting in 2023 if other Members are not ready yet.
8. Under the communication among Japan, Thailand and TCS, MLIT of Japan is planning to jointly host WGH 12th working meeting with RID of Thailand with funding support in Bangkok, Thailand.
9. As the situation of COVID-19 epidemic improves, WGH agreed to enhance the cooperation with RAI Coordination Panel on Hydrology and Water Resources (CPH, former RAI Working Group on Hydrological Services) under the coordination of TC WGH vice chairperson Dr. Hyo-Seob CHO as the Chair of the WMO RAI CPH.
10. Dr. Hwirin Kim, Head of Hydrological and Water Resources Services Division (HWR) of WMO, had a very positive response on making a synergy between TC WGH and RAI CPH.

II. The Summary of Member Report on Hydrological Component in 2022

11. The WGH reviewed the flood-related disaster happened in 2022 and hydrological activities conducted in Members in the year, and also noted the special measures took in Members for flood disaster risk reduction under the situation of COVID-19.
12. In 2022, Cambodia was experiences heavy rainfall from May to October that caused by strong monsoon trough and Tropical Cyclone NORU (2216). During 11 to 28 September the exceeded of rainfall amount caused the O' Sandan dam in Battambang province' s Bavel district was collapsed, some location in Battambang, Banteay Meanchey, Kratie, Kampong Cham, Kampong Chhnang, Kampong Speu, Mondol Kiri, Oddar Meanchey, Pursat, Preah Vihear, Siem Reap, Stung Treng, Kampong thom, and Phnom Penh were flash flood and flood.
13. In 2022, in China, four of the twenty typhoons generated in northwest pacific ocean landed in China, among which 'Chaba' brought the most series storm and flood to the middle and east area of China. Affected by the heavy rainfall, 122 rivers in seventeen provinces, including Hainan, Guangdong, Guangxi, Fujian, Hunan, Jiangxi, Jiangsu, Anhui, Shandong, etc., experienced floods exceeding the warning level with a range of 0.01 ~ 5.93 m, among which, the North River of Guangdong province witnessed the third Numbered flood of 2022.
14. Six tropical cyclones affected Hong Kong, China in 2022. Three of them, namely Chaba, Ma-on and Nalgae, necessitated the issuance of the No.8 Gale or Storm Wind Signals in Hong Kong. In particular, Nalgae moved very close to Hong Kong in early November 2022, necessitating the issuance of Gale or Storm Wind Signal in November again since 1972. At least three persons were injured in Hong Kong during the passage of Chaba. Under the high winds brought by Nesat, seven passengers were injured when a double-decker bus was hit by a fallen tree. One person was injured during the passage of Ma-on. In terms of heavy rain associated with tropical cyclones, tropical depression and Mulan in August 2022 brought more than 100 millimetres of rainfall over Hong Kong.

For hydrological activities, the Drainage Services Department (DSD) has developed a Hydrometric Information System (HIS) to facilitate monitoring of real-time hydrometric data and analysis of flooding situations through mobile phones and computer systems in a timely manner so that DSD can coordinate with the relevant departments to prepare for rescue and evacuation operations when necessary. Recent innovative development on HIS is its automatic detection of potential flooding cases by setting logic in terms of weather condition and real-time water levels in DSD's drainage facilities, especially at flood-prone locations. This

innovation enables automatic arrangement of immediate drainage inspection and just-in-time clearance and helps not only optimize manpower resources deployment in handling potential flooding cases at night time, but also minimize the flood risks at different locations in a systematic manner. With this innovation on HIS, the reliability and robustness of the drainage system and flood control strategy in Hong Kong, China to deal with upcoming challenges such as climate change and extreme weather events could be reinforced.

15. In 2022, in Japan, the 4th Asia-Pacific Water Summit was held in Kumamoto City in April 2022. The Kumamoto Initiative for Water promotes both climate change adaptation and mitigation measures, including climate change adaptation to reduce the risk of water-related disasters and climate change mitigation to develop infrastructure and hybrid technologies to reduce greenhouse gas emissions. The measures proposed include: 1) providing satellite data to compensate for the lack of ground observation data; 2) using AI/IoT-based forecasting and analysis technology to improve water-related disaster risk assessment; and 3) supporting human resource development. Specific methods include: 1) Providing Satellite Data & Creating Climate Change Projection data, and 2) Flood Simulation for the Risk Evaluation.
16. Until October of 2022, Lao PDR was affected by Three tropical Cyclones: T2207 Mulan during 6-14 August 2022, T2209 Ma-on during 26-28 August 2022, and T2216 Noru, during 27-28 September 2022. Monthly rainfall this year is higher than average in May, July, August, and September (especially in August where Lao PDR was affected by two tropical cyclones in a month). Natural Disaster such as Heavy Rainfall, Strong wind and Thunder, Flood, Flash Flood, Urban Flood and Landslide occurred frequently and Affected 12 provinces in Laos (more than last year which 9 provinces were affected). The Most damaged Region where flood and flash flood occurred were in the northern (two death was reported) and southern region of the country. The total damage from Flood is estimated to be around 14,544,839 US Dollar.
17. In 2021, Malaysia experience significance number of floods throughout the country. 1057 flood events were recorded in 2021, which is more than 188 flood events compared to 2020. In addition, the flood events recorded between 2001 and 2021 show an average of 278 flood events every year. Furthermore, the Department of Irrigation and Drainage (DID) is developing a flood forecasting and warning system that includes the construction of hydrological telemetry stations, development of flood forecasting model, forecast data centre and monitoring systems and public awareness programme. It is planned that almost 2,600 hydrological stations will be built within 15 years. Currently, flood forecast model has been developed for 25 river basins. At the same time, there are several monitoring equipment ready to operate including 1,180 hydrological telemetry stations, 1,571 manual flood gauges, 103 flood warning board, 526 automatic flood warning siren and 68 web cameras.

Malaysia is also committed to the AOP program under the ESCAP/WMO Typhoon Committee, particularly for the Annual Operating Plan (AOP), including AOP2: Application of Hydrological Data Quality Control System in TC Members, Annual Operating Plan; AOP4: OSUFFIM Phase-II: Extension of OSUFFIM Application in TC Members, Annual Operating Plan; AOP5: Impact Assessment of Climate Change on Water Resources Variability in TC Members and Annual Operating Plan; and AOP6: Flood Risk Watch Project Life-Saving. In 2022. Among them, AOP6 showed excellent progress related to the 3L water level gauge test in Malaysian rivers. The implementation of AOP6 has involved five (5) companies from Japan where with the cooperation from DID Malaysia, IDI Japan and local companies, the water level equipment has been installed for further testing.

18. In 2022, a total of 15 Tropical Cyclones (TC) entered the Philippine Area of Responsibility (PAR). Of these, three (3) brought huge damages in terms of lives and properties. As a rule, they will be decommissioned and replaced with other TC names in 2024.

PAGASA issued a total of 60 Flood Bulletins / Advisories / Information for the 18 major river basins of the Philippines. A total of 1,680 General Flood Advisories (GFAs) were issued. GFA is a special warning information which is issued whenever there is threat flooding within principal and other river basins outside of the major ones.

19. In 2022, Republic of Korea (ROK), of the 23 typhoons occurred this year (as of 1 November 2022), there were a total of 5 typhoons that directly or indirectly affected South Korea; however, the only typhoon that landed on the country was Typhoon No.11 HINNAMNOR from August 28 to September 6, 2022.

Typhoon HINNAMNOR caused damage to cities in the southern region of South Korea. Depending on the HINNAMNOR's moving route, damage occurred one after another in southern regions such as Jeju Island, Busan, and Pohang. On the day of its landing, the damage estimated for one day on September 6 alone approached 4 billion won, and the damage to the agricultural and fisheries sectors was large in terms of simple property damage. As it approached Jeju Island in the southern sea of Korea prior to landing, it already caused damage such as damage to facilities, flooding, and power outages in various places in the city. All schools in the Jeju area decided to close or remote online learning, and to adjust school hours. After causing casualties including 11 dead and 1 missing, HINNAMNOR passed through the southern coast of Jeollanam-do, South Korea, and landed near Geoje, Gyeongsangnam-do, and escaped through the eastern coast. The estimate of total property damage caused by Typhoon HINNAMNOR was 244 billion won.

20. In 2022, Singapore reported that its weather had been affected indirectly by tropical cyclone/storm located over the western Pacific and the Indian Ocean. One example was the "Sumatra Squall" that developed under the influence of Typhoon Chiba on 30 June 2022 which brought heavy thundery showers and gusty winds to the island. Singapore also experienced heavy rain and strong winds due to the Tropical Depression 29W which came close to the island between 16 – 18 December 2021. Singapore reported the occurrences of flash flood that took place on 27 February 2022, 2 March 2022 and 7 March 2022 due to localised thunderstorms.

Singapore also updated on the progress of the KRA in the following regional activities, which had contributed to Southeast Asia's capability building in the area of extreme weather:

- Southeast Asia Regional Climate Centre Network (SEA RCC-Network).
- ASEAN Climate Outlook Forum (ASEANCOF).
- Subseasonal-to-Seasonal Predictions for Southeast Asia (S2S-SEA).

To aid in flash flood response in Singapore, the Meteorological Service Singapore (MSS) is developing radar-based rainfall forecast with short lead-time (nowcast). The development of the prototype is focused on ensuring high quality of radar data, signal processing and bias correction as well as validating various methods of extrapolating/forecasting precipitation fields.

21. In 2022, from January to October, Thailand confront with 4 tropical storms that weaken into depression and strong low pressure cell as: 1) MULAN (2207), on 9-11 August 2022, affected to Chiangrai, Nan, Maehongson, Phitsanulok, Phetchabun, Loei, Sakaew and Prachinburi; 2) MA-ON (2209), on 24-26 August 2022, affected to Lampang, Udonthani, Khonkaen, Chaiyaphum, Ubonratchathani, Nakhonnayok, Rayong and Ayuthaya; and 3) NORU (2216), on 27-29 September 2022, major affected to Mun river (Ubonratchathani province), Pasak and Chaophraya river (many provinces in the Central Part and Ping river in Chiangmai also impacted; and 4) SONCA (2219), on 14-17 October 2022, affected to the inundation area in Northeastern, Central and made flood occurred in Southern part of Thailand. In addition, the strong monsoons caused more than 100 hydrological stations and around 60 provinces flooded in Thailand.

The Office of the National Water Resources set up '13 Measures for Rainy Season 2022' for the related agencies such as: 1) Forecasting and targeting flood-prone and less average rainfall areas. 2) Managing lowland areas for flood retention. 3) Reviewing and adjusting water management criteria for large and medium water resources and diversion dams. 4) Repairing and improving hydraulic structures, drainage systems, and telemetering stations. 5) Improving and solving water obstacles. 6) Dredging canals and removing water hyacinths. 7) Preparing and planning of machine and equipment for flood-prone and less average rainfall areas. 8) Increasing water efficiency and improving water distribution methods. 9) Checking the security of the levee, dam, dyke. 10) Preparing evacuation areas and exercising the Incident Action Plan.

11) Setting up the Front Area Command Center. 12) Raising awareness and public relations. And 13) Monitoring, evaluating and adjusting measures in accordance with the disaster situation.

The Royal Irrigation Department (RID), Office of National Water Resources and related agencies were working together on monitoring, analyzing, providing information and supporting the instruments and technology to the community.

22. In the region of Guan, USA, the end of 2021 through 2022 saw below normal to slightly below normal rainfall across the Marianas. Micronesia, with the exception of Yap State, saw well above to above normal rainfall, with Yap State slightly below normal. Although rainfall improved to current above normal totals, the end of 2021 and beginning of 2022 were very dry for some locations. The end of 2021 and beginning of 2022 saw drought conditions across portions of Pohnpei and Chuuk States and the Republic of the Marshall Islands. Most of the systems developing into tropical cyclones in late 2021 and 2022 formed north and west of the islands, resulting in these drier conditions.

A La Nina pattern continued through 2022 resulting in a northward and westward displacement of TC formation. A number of developing tropical systems moved through the region as only disturbances or invest areas. Only three cyclones affected the region through 2022, they were Typhoon Rai in December, 2021, and Typhoon Malakas in April 2022 and tropical depression 27W in Oct 2022 that transited Palau and developed into Banyan as it pulled away.

Dry conditions developed over the northern Marshall beginning in January 2022. Dry conditions eased over southern Pohnpei State in late January 2022, to again return in June 2022. Drought continued over Kapingamarangi, FSM into late October. Drought Information Statements (DGT) were provided by WFO Guam on a bi-weekly basis or as needed through the year.

Dry conditions developed over northern Chuuk State beginning in February 2022. In all, 26 DGT products were issued. Beneficial rains eased the water shortage in Chuuk State in March 2022 and around late May to early June 2022 in the Marshall Islands. Although drought conditions existed, they were less severe than in 2017.

Only three tropical cyclones affected Micronesia since November 2021, with none directly affecting the Marianas. In December 2021, Typhoon Rai moved through portions of Yap State and the Republic of Palau as a Tropical Storm, affecting several islands as it moved through.

Although typhoon watches and warnings were issued, Rai did not reach typhoon strength until well northwest of Micronesia. Rai did bring beneficial rains to Yap State and Palau. In April 2022, Typhoon Malakas moved through eastern Yap State, affecting several islands. Malakas remained a tropical storm until well north of Yap State and west of the Marianas. Eastern Yap State received beneficial rains from Tropical Storm Malakas and the ensuing wet southwesterly monsoon flow. In October 2022, Tropical Depression Banyan (27W) developed over the Republic of Palau and brought torrential rain and gusty winds with it. In fact, the monthly rainfall totals for the Republic of Palau ranged from 13 to 28 inches (352 to 698 mm) and exceeded several rainfall records across the country.

Other hydrologic events in the Marianas Islands during the past year have resulted in the issuance of several hydrologic products over the past year, mostly during the past six months. These products ranged from Hydrologic Outlooks to Urban and Small Stream Flood Advisories to Flash Flood Watches and Warnings.

23. In 2022, Vietnam reported that the general behaviour of flood situation in Viet Nam in reporting time mentioned as below:
- The flood season in northern Vietnam has come to the end, while in the central and southern part have been entering the most intense period of flood season.

- In the Northern part: the flood plain situation occurred at the beginning of September leading to severe inundation in Ha Noi capital outskirt. Flash floods and landslides are dangerous hydrological phenomena that have taken place in the northern mountainous areas.
- In the Central: Severe flooding occurred in several Central’s provinces as results of TY named NORU (27-29/9) and Storm SONCA (14-15/10). A lot of provinces in Central and Highland regions were suffered the terrible damage which can be listed as Nghe An, Ha Tinh, Thua Thien Hue, Quang Ngai, Quang Nam, Da Nang, Quảng Bình, Quang Tri, Kon Tum.

Reporting of the Southeast Asian Flash flood guidance system (SEAFFGS) situation in Viet Nam Meteorological and Hydrological Administration (VNMHA) is:

- In 28 June, 2022: The official launch of the Southeast Asia Flash Flood Guidance System (SeAFFGS) in Ha Noi, Viet Nam.
- High challenges in operation: Lacking data situation of telemetry rainfall and radar leading to decline in the quality and reliability of the computational products in the system.
- Finding a lot of trouble in data storage and system maintenance.

With many difficulties and challenges mentioned above, it is not yet ready to launch the SEAFFGS project as one WGH AOP in 2023.

III. Progresses of WGH AOPs in 2022 and Implementation Plan for 2023

24. The project leaders and/or their representatives from China, Japan, Republic of Korea presented the progresses in 2022 and the implementation plan for 2023. The participants reviewed and discussed the implementation status in 2022 and the success indicators for 2023 of WGH AOPs.
25. The WGH AOPs in 2022 and beyond was summarized in the table 1. The implementation status of WGH AOP 2022 is summarized in the Annex 1.

Table 1 The list of WGH AOPs in 2022 and beyond

Item	Projects	Driver	Duration
AOP1	Knowledge Sharing on Storm Surge Inundation Mapping	USA	2020-2025
AOP2	Application of Hydrological Data Quality Control System in TC Members	ROK	2018-2022
AOP3	Enhancement of Flood Forecasting Reliability with Radar Rainfall Data and Stochastic Technique	ROK	2018-2022
AOP4	OSUFFIM Phase-II: Extension of OSUFFIM Application in TC Members	China	2018~2023
AOP5	Impact Assessment of Climate Change on Water Resource Variability in TC Members	China	2018~2024
AOP6	Flood Risk Watch Project for Life-saving	Japan	2019~2023
AOP7	Platform on Water Resilience and Disaster under IFI	Japan	2019~2022

AOP1: Knowledge Sharing on Storm Surge Inundation Modeling

26. The leader of this project Mr. Kenneth Kleeschulte from National Weather Service (NWS), Weather Forecasting Office (WFO) Guam briefed the Pacific Ocean Storm Surge Inundation Modeling (POSSIM) and the its application.
27. POSSIM is adapted from the Back Of The Envelope Surge (BOTES) methodology used in the Gulf of Mexico by WFO New Orleans/Baton Rouge (WFO LIX). The technique takes a standard tropical cyclone advisory and applies it through GIS mapping tools to compute areal storm surge forecasts along a storm track. When Digitized Elevation Model (DEM) data are utilized in conjunction with the storm surge output, then an inundation map is the result. This method uses high resolution Light Detection and Ranging (LiDAR) data as the DEM of choice. The surge computations are based on hydrostatic principles on pressure differentials between the storm environment and the ambient environment. This concept follows closely to Greg Holland equations and uses Haversine math for spherical distance calculations and Knaff-Zehr pressure-wind relationships. The advantage of this technique is a more timely generation of storm surge/inundation mapping for local situational awareness, leveraging the available technologies to convey the messages for this particular storm threat upon vulnerable populations.
28. Mr. Kenneth Kleeschulte stated that, due to COVID 19 restrictions over the past 3 years, AOP1 has not yet been started the piloting study in Members fundamentally. WFO Guan is currently soliciting interested Members, and them a copy of the program POSSIM will be provided to the interested Members as well as training on use and update of bathymetry data in 2023 and beyond.
29. The Members are requested to contact Mr. Kenneth Kleeschulte as soon as possible concerning interest in participation in the program. TCS will provide necessary secretariat support if needed.
30. Up to November 2022, China, Republic of Korea and Thailand expressed their interests in taking part in this project.

AOP2: Application of Hydrological Data Quality Control System in TC Members

31. At TC 54nd Session, following activities were scheduled for the project on Application of Hydrological Data Quality Control System in 2022:
 - To finalize the establishment of the hydrological data quality control system (PC-version);
 - To publish the hydrological quality control system manual as final technical report of the project.
32. Han River Flood Control Office (HRFCO) in cooperation with Korea Institute of Civil Engineering and Building Technology (KICT) pushed this project forward in 2022. The implementation status and progresses were described as below:
 - To finalize the establishment of the hydrological data quality control system (PC-version)
 - Report the development of system in 11th TC WGH Meeting and conduct demand analysis
 - Conduct system testing for 4 pilot target TC members (Malaysia, Lao P.D.R, Thailand, Philippines and analyze the testing output
 - Final improvement and report the finalization of development system in 17th IWS
 - Finalizing the draft of the system manual.
 - Print out the system manual and disseminate it after TC 55th Session in 2023
33. Han River Flood Control Office (HRFCO) in cooperation with Korea Institute of Civil Engineering and Building Technology (KICT) hosted the virtual workshop for the hydrological data quality control system developed from AOP2 on November 18, 2022. The purpose of the workshop was to introduce the development status on the system, demonstrate the system operation, and listen to Members' needs for future system improvement. The workshop was attended by 12 participants from 3 pilot target Members, TCS and

the host. Inevitably, the expected participants from Malaysia was unable to attend due to the scheduling of the General Election, but the major outcomes of the workshop were shared.

34. The project which was launched in 2018 will be officially closed at TC 55th Session to be held in early 2023. The participating Members expressed their appreciation to KICT team on their contribution to the cooperation project.

AOP3: Enhancement of Flood Forecasting Reliability with Radar Rainfall Data and Stochastic Technique in TC Members

35. At TC 54th Session, the following activities for the project on Enhancement of Flood Forecasting Reliability with Radar Rainfall Data and Stochastic Technique were scheduled in 2022 as:

- To develop the stochastic flood forecasting system
- To publish the stochastic flood forecasting system manual as final technical report of the project

36. The implementation status and progresses in 2022 were described as:

- To develop the stochastic flood forecasting system
 - Finalize the system development and report the progress at 17th IWS
- Submit the draft system manual to TCS in December in 2022 and finalize it.
 - Print out the system manual and disseminate it after TC 55th Session in 2023

37. The project which was launched in 2018 will be officially closed at TC 55th Session to be held in early 2023. The participating Members expressed their appreciation to KICT team on their contribution to the cooperation project.

AOP4: OSUFFIM Phase-II: Extension of OSUFFIM (Development Operational System for Urban Flood Forecasting and Inundation Mapping) Application in TC Members

38. At TC 54th Session, the following activities for the project on OSUFFIM Phase-II: Extension of OSUFFIM (Development Operational System for Urban Flood Forecasting and Inundation Mapping) Application in TC Members were scheduled in 2022 as:

- By 30 May 2022, complete the hydrological data collection for the pilot studies in Malaysia, Philippines, and China.
- By 31 July 2022, complete parameter optimization of the pilot studies in Malaysia, Philippines, and China.
- From 1 August to 31 December 2022, complete the trial operation of real-time flood forecasting of the pilot studies in Malaysia, Philippines, and China.
- By 31 March 2023, complete project conclusion and workshop in Guangzhou, China.

39. The implementation status and progresses of the project achieved in 2022 were described as:

- Liuxihe model has been set up for the flood forecasting of Chebei creek as the pilot study in China, and put into real time operation in flood season in 2022;
- Liuxihe model has been set up for the flood forecasting of Pinang catchment as the pilot study in Malaysia;
- Liuxihe model has been set up for the flood forecasting of Matina catchment as the pilot study in Philippines.

40. The implementation plan is scheduled in pilot river basins for 2023 as:

- Improving parameter optimization for the pilot studies in Malaysia, Philippines, and China;
 - Conducting trial operation of real-time flood forecasting of the pilot studies in Malaysia, Philippines, and China;
 - Organizing project workshop, online or offline (TBD);
 - Final project conclusion
41. The representative from Vietnam requested AOP4 leading team to consider the possibility of OSSUFIM piloting study in selected river basin of Vietnam and to provide the implementation plan soon for Vietnamese team's preparation.
42. As requirement of Vietnam, OSUFFIM team leader considered to have a video meeting in March or April 2023 to discuss how to process the pilot study of OSUFFIM in Vietnam, including providing recent observed hydrological data for parameter optimization, and real-time data for flood forecasting, etc.

AOP5: Impact Assessment of Climate Change on Water Resource Variability in TC Members

43. At TC 54th Session, the following activities for the project on Impact Assessment of Climate Change on Water Resource Variability in TC Members were scheduled for 2022 as:
- To organize 1-2 online or offline (face-to-face) training workshops, subject to the situation of COVID-19. Participating Members will be invited to share their successful case studies and lessons learnt from using the RCCC-WBW model in their countries.
 - To improve RCCC-WBM model by adding flow duration curve module.
 - To publish the technical report of Impact Assessment of Climate Change on Water Resources Variability.
44. The implementation status and progresses in 2022 were described as:
- The RCCC-WBM model was improved by adding flow duration curve module and software was registered.
 - 25 catchments with different hydro-meteorological characteristics were selected. The improved model was applied to these catchments. simulation for low flow was well improved by considering flow duration curve.
 - Technical Report of “RCCC model and its application for Impact Assessment of Climate Change on Water Resource Variability” was published as TC publication (TC/TD-No. 0023).
45. The implementation plan is scheduled for 2023 as follows:
- To organize face to face training workshops in 2-3 TC countries (approximately 7-9 days in total). Training workshops will focus on (1) Data acquisition and evaluation, (2) Model calibration and application
 - To extend RCCC-WBM model application in interested TC members for assessing climate change impact, and exchange experiences and lessons of model application
 - To provide guidance on case studies of typical catchments in interested TC members by using the RCCC-WBM model and understanding practical situation of catchments for supporting climate change adaptation and water resources management

AOP6: Flood Risk Watch Project for Life-saving

46. At TC 54th Session, the following activities for the project on Flood Risk Watch Project for Life-saving were scheduled in 2022 as:

- Malaysia and Japan will install and test observe WLG in Malaysia in 2022.
 - Testing will be conducted for more than 6 months to confirm observation performance and maintenance performance.
47. The implementation status and progresses in 2022 were described as:
- MLIT recruited WLG manufacturers to participate in the 3L WLG test installation plan, and four companies decided to participate in the test installation.
 - Malaysia and Japan have resumed concrete activities to start 3L WLG installation and test observations in the first half of 2022.
 - End of 2021: WLG manufacturers participating in the test construction have developed 3L WLGs that meet Malaysian specifications.
 - July 2022: all WLG manufacturers brought their 3L WLGs to Malaysia and installed them in the test site.
 - All companies started test observations in late July 2022.
48. The representative from DID Malaysia briefed the progresses of AOP6 piloting study since 2018 as well as current status, issue and challenges of 3L water level gauge (3L WLG) testing programme in Malaysia in 2022. The following challenges were stressed:
- Elevation settings of all WLGs based on stick gauge readings by the installers may cause differences in water level data between WLG.
 - Exposed riverbed during low water level (below 20m) due to sedimentation may cause error in water level data.
 - One of 3L WLG (AOP6-1) has not sending data since 21st of August due to a power failure which will make comparisons with other 3L WLGs incomplete.
49. The implementation plan is scheduled for 2023 as:
- After July 2022: Start test observations (at least six months) to check the accuracy of observation data, operability of equipment, etc.
 - Until March 2023: Adjustment of observation accuracy, status of data transfer to the server, and evaluation of observation accuracy.
 - April 2023: removal of WLGs
 - Opportunities are provided to inform other Member States of the results of the test observations.

AOP7: Platform on Water Resilience and Disasters under IFI (International Flood Initiative)

50. At TC 54th Session, the following activities for the project on Platform on Water Resilience and Disasters under IFI were scheduled in 2022 as:
- Hands-on Training Workshop is scheduled as the Second Phase, including:
 - How to use Online Synthesis System (OSS)
 - Training on 2D & 3D flood mapping
 - Training on contingency planning
 - Communication planning
51. The implementation status and progresses in 2022 were described as:
- The hands-on training was conducted for Davao City in the Philippines by remotely gathering 31 participants from different disciplines and sectors of local society
 - Participants produced several types of hazard maps and contingency plans considering local climate change impacts and discussed their deliverables with a local sense

- Participants have also developed action plans to disseminate integrated knowledge and insights to local stakeholders as Facilitators who will interlink science and technology and local society
 - Online Synthesis System for Sustainability and Resilience (OSS-SR) has been updated to upload local knowledge and status
52. The project which was launched in 2019 will be officially closed at TC 55th Session to be held in early 2023. The participating Members expressed their appreciation to Japan experts for their contribution to the cooperation project.

New AOP2: Improvement of Hydrological Data Quality Control System by Using AI technology

53. Following the decision at TC 54th Session, the project on Improvement of Hydrological Data Quality Control System by Using AI technology with 5 years period from 2023 to 2027, proposed by HRFCO in cooperation with KICT, will be launched officially at TC 55th Session as WGH new AOP2.
54. The activities/implementation plan for the project in 2023 are described as below:
- To conduct application and practical testing in 4 pilot target TC Members (Malaysia, Lao P.D.R, Philippines, Thailand);
 - To conduct requirement analysis and gathering the opinions and comments from TC Members
 - To update and modify the hydrological quality control system and select the new technique for system upgrading
55. Development of hydrological data quality control system using AI will be completed in 2027 and the technical report & system manual will be published.

New AOP3: Improvement of Flood Forecasting modelling by Using AI technology

56. Following the decision at TC 54th Session, the project on Improvement of Flood Forecasting modelling by Using AI technology with 5 years period from 2023 to 2027, proposed by HRFCO in cooperation with KICT, will be launched officially at TC 55th Session as WGH new AOP3.
57. The activities/implementation plan for the project in 2023 are described as below:
- To conduct the application and practical testing in TC Members
 - To conduct requirement analysis and gathering the opinions and comments from TC Members
 - To establish the modification plan of the Extreme Flood Forecasting System (EFFS) and select the upgrade item for operating system
58. Development of flood forecasting system using AI will be completed in 2027, and the technical report and the system manual will be published.

New AOP7: Flood resilience enhancement through Platform on Water Resilience and Disasters

59. Following the decision at TC 54th Session, the project on Flood resilience enhancement through Platform on Water Resilience and Disasters with 5 years period from 2023 to 2027, proposed by ICHARM, will be launched officially at TC 55th Session as WGH new AOP7.
60. The development of OSS-SR and fostering Facilitators will be initially implemented in Davao City, the Philippines, and will also engage other interested members/stakeholders. The implementation will be completed in 2027 and achievements will be published officially.
61. The following activities/implementation plan for the project in 2023 are described as below:

- To develop and improve OSS-SR which will integrate knowledge, technology, know-how, and experience of different disciplines related to flood disasters
- To conduct capacity development to foster local Facilitators utilizing OSS-SR as an E-learning tool
- To cooperate with Facilitators for disseminating scientific knowledge and technology to local stakeholders relevant to water-related disaster management
- To cooperate to implement the activities above with other working groups of the Typhoon Committee

AOP Proposal: Knowledge Sharing on the Southeast Asia Flash Flood Guidance System (SeAFFGS)

62. The project on the Southeast Asia Flash Flood Guidance System (SeAFFGS), was launched officially in Ha Noi, Viet Nam on 28 June 2022.
63. The training on “Exploitation and application of the SeAFFGS in flash floods and landslides warning” was held for the local forecast centers in Viet Nam on 25-29 July 2022.
64. Considering the high challenges in operation of SeAFFGS, including (1) lacking data situation of telemetry rainfall and radar leading to decline in the quality and reliability of the computational products in the system, and (2) problems in data storage and system maintenance, MHA of Vietnam deemed that it is not yet ready to launch the project at coming TC 55th Annual Session to set this project as one WGH AOP in 2023 and beyond.
65. The participants recognized that flash flood is a common challenge in TC Members. To share the knowledge of flash flood guidance among Members is very important on promotion of the capacity of flash flood related disaster prediction and early warning. MHA of Vietnam has initiated a very good project on the Southeast Asia Flash Flood Guidance System (SeAFFGS) which will definitely benefit all TC Members. The participants sincerely expressed their expectation to MHA of Vietnam to officially launch this project when it is ready to do so.
66. The representatives from MHA of Vietnam expressed their appreciation for Members’ encouragements, and requested WGH and TCS to provide assistants on the solution of challenges faced in operation.

SSOP-III

67. Mr. Tom Evans, Co-Vice-Chair, Advisory Working Group (AWG) of Typhoon Committee (TC), introduced the concept of Synergized Standard Operating Procedures for Coastal Multi-Hazard Early Warning System (SSOP)-Phase III for discussion.
68. The multi-hazard early warning has two (2) Key elements:
 - People-centered, bottom-up approach
 - Channels of communications
 - Building awareness into the structure of communities
 - Involvement of local communities in data collection
 - Hazard Awareness and education
 - Know specific actions needed to reduce risk
 - Know their actions will be effective
 - Believe in their own ability to take the actions
 - Receive validation from several sources (one message – many voices)
 - Know others will take action too
69. The multi-hazard early warning should focus on four (4) basic requirements
 - Alert, informed, active and adequately prepared community members;

- Effective community-based organizations with identified, defined and constructive roles in local emergency management arrangements;
 - Local governments that acknowledge their roles in community safety issues and have well established, widely understood and practiced arrangements for discharging their community safety responsibilities; and
 - Organizations and communities are able to work together to respond to the emergency, save lives and property, and assist the community in rescue, relief and recovery.
70. The multi-hazard early warning system should concentrate on
- Identifying vulnerable communities
 - Building relationships with community leaders
 - Listening to the concerns of the community
 - Learning from the local knowledge
 - Educating and training those within the community
 - Developing local MHEWS SSOPs
 - Exercising these local MHEWS SSOPs
71. Participants recognized the SSOP-III is a meaningful proposal to TC Members, and agree to set SSOP-III as an AOP of WGH. Participants also discussed the involvement of WGH in SSOP-III and the implementation schedule and activities for SSOP-III.
72. Mr. Tom Evans expressed that USA would like to play the role as the driver of SSOP-III. The participants expressed their gratitude.
73. WGH AOP leaders expressed their willingness to combine their activities (such as training, missions) and research results with SSOP-III activities.

Training Course on Hydrological Monitoring and Flood Management for Developing Countries

74. Ms. ZHOU Ruide, the representative from Nanjing Research Institute of Hydrology and Water Conservation Automation (NIHWA), the Ministry of Water Resources, China introduced **the information** of Training Course on Hydrological Monitoring and Flood Management for Developing Countries (26 October ~ 8 November 2022) , which is an annual training programme for developing countries covering most TC and PTC Members.
75. The participants expressed their appreciation to NIHWA for sharing the training information and request China to consider the possibility of combining this annual training course with TC WGH activities as one of AOPs, so that TC Members can benefit from the training programme including facilitates, expertise and funding resources in future.
76. The Workshop was opened on 26 October 2022 with more that 83 attendances from 15 countries, including 4 TC Members namely: Cambodia, Lao PDR, Malaysia and Philippines. Dr. Mamoru MIYAMOTO, TC WGH Chairperson, delivered a speech at the opening ceremony as invited guest.
77. Considering the contribution and cooperation from TCS hydrologist, the workshop listed ESCAP/WMO Typhoon Committee as one of organizers. NIHWA and TC WGH reached the consensus on that more Members of TC Members may involved in this training course in future.
78. As requested from Members, China agreed to officially launch Training Course on Hydrological Monitoring and Flood Management for Developing Countries as WGH AOP8 at TC 55th Session. This AOP will be executed in the period of 3 years from 2023 to 2025. A two-week training course will be held annually with funding support from China government in forms of video, hybrid or face-to-face, depending on the situation of the COVID-19.

WGH Web-page

79. The representatives from HRFCO and KICT stated that, considering the changed security policy in the Republic of Korea since 2017, the strategy of maintaining and operating the WGH web-page should be changed and advised that, for an effective maintenance and easy accessibility, WGH web-page may be considered to integrate with TC web-page.
80. The participants expressed their understanding on the statement from the representatives of HRFCO and KICT, and expressed their sincere appreciation to HRFCO with cooperation of KICT for their maintaining and operating the WGH web-page in the past years.

Summary of WGH AOPs in 2023 and beyond

81. The WGH AOPs for 2023 and beyond were summarized in Table 2, and the success indicators of AOPs for 2023 are shown in Annex 2.

Table 2: The list of WGH AOPs in 2023 and beyond

Item	Projects	Driver	Duration
AOP1	Knowledge Sharing on Storm Surge Inundation Mapping	USA	2020~2025
AOP2	Improvement of Hydrological Data Quality Control System by Using AI technology	ROK	2023~2027
AOP3	Improvement of Flood Forecasting modelling by Using AI technology	ROK	2023~2027
AOP4	OSUFFIM Phase-II: Extension of OSUFFIM Application in TC Members	China	2018~2023
AOP5	Impact Assessment of Climate Change on Water Resource Variability in TC Members	China	2018~2024
AOP6	Flood Risk Watch Project for Life-saving	Japan	2019~2023
AOP7	Flood resilience enhancement through Platform on Water Resilience and Disasters	Japan	2023~2027
AOP8	Training Course on Hydrological Monitoring and Flood Management for Developing Countries	China	2023~2025
AOP9	Synergized Standard Operating Procedures for Coastal Multi-Hazard Early Warning System (SSOP)-Phase III	USA	2023~2025

IV. WGH Chairmanship

82. The participants expressed their appreciation to Dr. Mamoru Miyamoto from Japan serving as WGH Chairperson, Dr. CHO Hyo Seob from Republic of Korea, Dr. HOU Aizhong from China, and Mr. Kenneth KLEESCHULTE from USA serving as Vice-chairpersons for their hard work and contribution in the past two-year term.

83. The Members requested Dr. Mamoru Miyamoto to continue serving as WGH Chairperson, Dr. CHO Hyo Seob, Dr. HOU Aizhong, and Mr. Kenneth KLEESCHULTE to continue serving as Vice-chairpersons for the next two years.
84. The Chairperson and Vice-Chairpersons expressed their gratitude for receiving request and encouragement from Members, and also expressed their commitment to continue serving for WGH.

V. Review TCTF allocation for WGH activities in 2022 and Proposed Request for 2023

85. WGH reviewed the allocation of TCTF (\$25000USD) for WGH activities in 2022 shown in table 3.

Table 3 The summary of TCTF Budget allocated for 2022 Activities

Item	Activities	Driver	Budget	Usage
1	Support the activities related to Knowledge Sharing on Storm Surge Inundation Mapping	USA	—	—
2	Support the activities related to Application of Hydrological Data Quality Control System in TC Members	ROK	3000	—
3	Support the activities related to Enhancement of Flood Forecasting Reliability with Radar Rainfall Data and Stochastic Technique	ROK	3000	—
4	Support the activities related to OSUFFIM Phase-II: Extension of OSUFFIM Application in TC Members	China	7000	—
5	Support the activities related to Impact Assessment of Climate Change on Water Resource Variability in TC Members	China	5000	4830.98
6	Flood Risk Watch Project for Life-saving	Japan	—	—
7	Support the activities related to Platform on Water Resilience and Disaster under IFI, including hosting the potential face-to-face WGH 11 th working meeting in 2022	Japan	7000	3000
	Total		25000	7830.98

86. The Participants expressed their highest appreciation to China, Japan, ROK, and other Members for their in-kind contribution in the year, and encouraged all Members continue their strong support.
87. Based on the discussion, WGH proposed the budget request of \$25,000USD for supporting its activities in 2023 shown in table 4.

Table 4 The summary of TCTF Budget Request for 2023 Activities

Item	Activities	Driver	Budget
1	Knowledge Sharing on Storm Surge Inundation Mapping	USA	6000
2	Improvement of Hydrological Data Quality Control System by Using AI technology	ROK	---
3	Improvement of Flood Forecasting modelling by Using AI technology	ROK	----

4	OSUFFIM Phase-II: Extension of OSUFFIM Application in TC Members	China	8000
5	Impact Assessment of Climate Change on Water Resource Variability in TC Members	China	5000
6	Flood Risk Watch Project for Life-saving	Japan	----
7	Flood resilience enhancement through Platform on Water Resilience and Disasters	Japan	----
8	Training Course on Hydrological Monitoring and Flood Management for Developing Countries	China	3000
9	Synergized Standard Operating Procedures for Coastal Multi-Hazard Early Warning System (SSOP)-Phase III	USA	----
10	Supporting hosting WGH 12 th working meeting in 2023		3000
	Total		25000

VI. Conclusions

88. On the basis of the discussion and outcomes at 11th WGH working meeting, participants recognized the importance in following aspects for further direction of WGH:

- WGH 11th working meeting was held in hybrid way. Partial participants from 5 Members joined the face-to-face meeting in Tokyo, Japan. To a certain extent it made the meeting a better effectiveness and efficient, especially to the sessions of technical discussion. Face-to-face meeting should be encouraged as far as possible in future if the condition of COVID-19 allows to do so.
- Due to climate change and urbanization, extreme hydro-meteorological events happened more frequently in past decades, especially the flash flood and landslides caused by local heavy rainstorm has become a major disaster risk, and its forecasting and warning rises big challenge in Asia and Pacific region. Every year huge economic damage and life losses caused by flash flood and landslides in TC Members. WMO Secretariat and National Meteorological and Hydrological services (NMHSs) have paid close attention and made great efforts on promoting the capacity of flash flood disaster forecasting and early warning. WMO has agreed to deliver Vietnam National Meteorological and Hydrological Administration (VNMHA) as a Regional Center for developing and implementing the SouthEast Asian Flash Flood Guidance System (SeAFFGS), and the project on SeAFFGS was launched officially in Ha Noi, Viet Nam on 28 June 2022. To share the knowledge of flash flood guidance among Members, MHA of Vietnam was encouraged to officially launch this project as WGH AOP when it is ready to do so.
- SSOP phase-I focused on analyzing status and summarizing the knowledge of operating procedures for coastal multi-hazard early warning system. SSOP phase-II focused on training and sharing the synergized knowledge on standard operating procedures (SOP) achieved from phase-I. SSOP-III is proposed to practice the knowledge of SSOP in operating procedures for coastal multi-hazard early warning, and will focus on the last mile at the local level. The proposed practice of SSOP will make Members know intimately the SOP for coastal multi-hazard early warning, consequently promote the capacity of coastal multi-hazard disaster risk reduction. As a very important link to coastal multi-hazard early warning and disaster risk reduction, hydrological component should be closely involved in the proposed SSOP phase-III.

- It is recognized that training is a very effective and important measure for TC Members to improve the capacity of their professional staff. In past years, WGH conducted a series of activities related to training courses and workshops including on-job training and achieved good results. In 2021, Nanjing Research Institute of Hydrology and Water Conservation Automation (NIHWA), the Ministry of Water Resources, China set a long-term programme of annual training course on hydrological monitoring and flood management for developing countries, covering some Members of TC and PTC. WGH persuaded of the merits of this programme to TC Members on sharing the resources including facilities, expertise and funding. On this connection, WGH requested China to consider the possibility of combining this long-term annual training programme with TC WGH activities as its one of AOPs.
- Due to the impact of COVID-19 in the past 3 years, the virtual conference became a normal format for WGs' annual meeting and TC integrated workshop (IWS). Due to the time difference and limited agenda, it is very hard for AOP leaders to have enough time for deep technical explanation and discussion at WGs' meetings and TC IWS. To resolve this problem, all AOP leading Members are encouraged to conduct extra workshop or training courses for their AOPs (on-line, hybrid, or face-to-face) with the purpose of deep technical training and discussion for AOP's implementation so as to keep its momentum and sustainability.
- It is a consensus on that, the working meeting of WGH is very important to review and push forward hydrological activities, and is very necessary to prepare IWS and annual session. WGH appreciated the generous contribution from Republic of Korea and Japan in the past years for hosting WGH working meetings. WGH also encouraged more Members to host its working meeting.
- As the situation of COVID-19 epidemic improves, WGH agreed to continue enhancing the cooperation with RA II, PTC and other regions, under the Cooperation Mechanism between TC and PTC, through involving more participants from outside of Typhoon Committee region in WGH working meeting. WGH expressed its willingness to make a synergy between TC WGH and RAI CPH (former WGHW) under WMO umbrella.

VII. Recommendations to the Committee

89. On the basis of the deep discussion and communication, participants agreed to submit the following recommendations to the Committee at TC 55th Annual Session to be held in early 2023:
- to re-appoint Dr. Mamoru MIYAMOTO from Japan as Chairperson, and to re-appoint Dr. CHO Hyo Seob from Republic of Korea, Dr. HOU Aizhong from China, and Mr. Kenneth KLEESCHULTE from USA to continue serving as Vice-Chairpersons for WGH in next two years.
 - to request US\$25,000 from TCTF for supporting overall WGH activities for 2023 calendar year.
 - to thank Japan for hosting the hybrid conference for WGH 11th Working Meeting on 18-19 October, 2022.
 - to request Japan and Thailand to jointly host WGH 12th working meeting in 2023 in Bangkok, Thailand.
 - to approve the project of "Improvement of Hydrological Data Quality Control System by Using AI technology" from Republic of Korea as one of AOPs of WGH in the period from 2023 to 2027.
 - to approve the proposal of "Improvement of Flood Forecasting modelling by Using AI technology" from Republic of Korea as one of AOPs of WGH in the period from 2023 to 2027.
 - to approve the proposal of "Flood resilience enhancement through Platform on Water Resilience and Disasters" from Japan as one of AOPs of WGH in the period from 2023 to 2027.
 - to approve the proposal of "Training Course on Hydrological Monitoring and Flood Management for Developing Countries" from China as one of AOPs of WGH in the period from 2023 to 2025.

- to approve the proposal of “Synergized Standard Operating Procedures for Coastal Multi-Hazard Early Warning System (SSOP)-Phase III” as one of AOPs of WGH in the period from 2023 to 2025, and USA plays the role of driver of this AOP.
- to thank HRFCO with cooperation of KICT, Republic of Korea for maintaining and operating the WGH web-page in the past year.
- 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 2022

Annex 2. Successor Indicators of WGH AOP 2023

Annex 1. Implementation Status of WGH AOP 2022

KRA	Objective Number	Objective	Action	Other WGs Involved	TCS Responsibility	Expected Quarter Completed	Other Organizations Involved	Success Indicators	Funding Required	Funding Sources	Status YES/NO
KRA 1 KRA 2 KRA 3 KRA 4 KRA 7	1	Knowledge sharing on Storm Surge Inundation Modeling	To share, prepare and localize Pacific Ocean Storm Surge Inundation Modeling (POSSIM) program with TC members (possibly PTC members in future)	WGDRR WGM	Coordination	(a) First (b) Second (c) Third (d) Fourth	To be determined	(a-b) Summary of interested TC members and coastal regions to be covered (c-d) Determination of availability of LiDAR and other bathymetry data (d) Determine necessary expert missions to provide local enhancements to program	---	WFO Guam	On-going Yes On-going
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	PAGASA, Philippines; DID, Malaysia; DMH, Laos; RID, Thailand	(a-c) Finalize the establishment of the hydrological data quality control system (PC-version) (d) Publication of the hydrological quality control system manual	3,000	HRFCO, ME	YES Postponed
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	PAGASA, Philippines; DID, Malaysia; DMH, Laos; RID, Thailand	(a-c) Develop the Stochastic Flood Forecasting System (d) Publication of the stochastic flood forecasting system manual	3,000	HRFCO, ME	YES Postponed
KRA 1 KRA 2 KRA 3 KRA 4 KRA 5 KRA 7	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	RID, Thailand; DID, Malaysia; MHA, Vietnam; PAGASA, Philippines	(a) OSUFFIM trial systems to be installed and trial operated in China. (b-d) OSUFFIM trial systems to be installed and trial operated in Malaysia or/and Philippines. (d) workshop in SYS Uni. or online.	7,000	HFC; SYS Uni. China	YES YES Postponed
KRA 3 KRA 6	5	Impact Assessment of Climate Change on Water Resource Variability in TC Members	Application of RCCC-WBM model at selected pilot catchments		See above	(a) First (b) Second (c) Third (d) Fourth	DID, Malaysia MHD, Laos	(b) improvement of RCCC-WBM model by adding flow duration curve module. (c, d) Online or/and offline training workshops on model application (c) publish the technical report on cases study of RCCC-WBM model application	5000	HFC and NHRI of China	YES Postponed Yes
KRA 1 KRA 2 KRA 3 KRA 4 KRA 5	6	Hydro Risk Watch Project for Life-saving	Promoting to install 3L water level gauge and flood forecasting system in TC Members	WGM	See above	(a) First (b) Second (c) Third (d) Fourth	DID, Malaysia	(a) Understanding Malaysia's required specifications (b) Customize 3L water level gauge to Malaysian specifications (c) Conducting test observations in Malaysia (d) Obtained performance certification from Malaysia DID		MLIT	YES YES YES On-going
KRA 1 KRA 2 KRA 3 KRA 4 KRA 5	7	Platform on Water Resilience and Disasters under the International Flood Initiatives (IFI)	Demonstrating the effectiveness of establishing the platforms on water resilience and disasters by involving the national government organizations for further improved flood management through	WGM WGDRR	See above	(a) First (b) Second (c) Third (d) Fourth	PAGASA DPWH, OCD TMD RID	(a-b) Hold the capacity development programs (b-c) Organize the session on the platform in the Philippines (b-c) Promote collaboration with the other WGs as a cross-cutting project (c-d) Organize the workshops for demonstration	7000	ICHARM MLIT	YES YES YES YES

KRA	Objective Number	Objective	Action	Other WGs Involved	TCS Responsibility	Expected Quarter Completed	Other Organizations Involved	Success Indicators	Funding Required	Funding Sources	Status YES/NO
			collecting data, transferring knowledge and enhancing the capacity					and dissemination at some major international events (d) Organize WGH 11 th working meeting in October 2022 in Japan			YES

- KRA 1: Enhance capacity to monitor the impacts of tropical cyclone related disasters, including reduction of mortality rates and direct economic losses, and strengthen tropical cyclone related disaster risk reduction (DRR) activities in various sectors.
- KRA 2: Enhance capacity in tropical cyclone forecast and disaster risk prediction using multi-hazard impact-based forecasts, risk-based warnings, understandable information designed in collaboration with users, and cutting-edge information technology, leveraged from the latest advances in big data analytics, artificial intelligence, machine learning, and social science to support early warning systems, decision making and disaster response.
- KRA 3: Improve flood mitigation measures and integrated water resource management to reduce the impacts of flooding caused by tropical cyclones.
- KRA 4: Strengthen capacity development activities in meteorology, hydrology, DRR and civil protection sectors, to enhance nationally to locally coordinated mechanisms for tropical cyclone early warning information to reach the last mile; and combine public awareness with the appropriate response to protect life and property from tropical cyclones.
- KRA 5: Promote visibility and enhance Typhoon Committee's Regional and International collaboration mechanisms to build partnerships, enhance capacity development, share best practices, and encourage active participation of international organizations in the disaster risk reduction programmes.
- KRA 6: Create a framework for cooperative scientific research on tropical cyclone and related disciplines, particularly in relation to climate change, and include support for translating research outcomes to services by developing relevant experiments, research projects, conducting field surveys, and publishing and promoting research findings.
- KRA 7: Enhance the resilience of vulnerable communities, especially coastal communities, to tropical cyclone impacts.

Annex 2. Success Indicators of WGH AOP 2023

KRA	Objective Number	Objective	Action	Other WGs Involved	TCS Responsibility	Expected Quarter Completed	Other Organizations Involved	Success Indicators	Funding Required	Funding Sources
KRA 1 KRA 2 KRA 3 KRA 4 KRA 7	1	Knowledge sharing on Storm Surge Inundation Modeling	To share, prepare and localize Pacific Ocean Storm Surge Inundation Modeling (POSSIM) program with TC members (possibly PTC members in future)	WGDRR WGM	Coordination	(a) First (b) Second (c) Third (d) Fourth	To be determined	(a-b) Summary of interested TC members and coastal regions to be covered (b-c) Provide the copy of the program POSSIM to the interested Members (c-d) training on use and update of bathymetry data and determine necessary expert missions	6000	
KRA2 KRA3 KRA4	2	Improvement of Hydrological Data Quality Control System by using AI technology	To apply, test and modify the TC member Hydrology Data Quality Control System		See above	(a) First (b) Second (c) Third (d) Fourth	PAGASA, Philippines; DID, Malaysia; DMH, Laos; RID, Thailand	(a-b) Apply and testing to pilot target TC members (c) requirement analysis and gathering TC Members' opinion (d) Modify the hydrological quality control system		HRFCO, ME
KRA2 KRA3 KRA4	3	Improvement of Flood Forecasting modelling by using AI technology	To establish the modification plan of EFFS and to apply in practical		See above	(a) First (b) Second (c) Third (d) Fourth	PAGASA, Philippines; DID, Malaysia; DMH, Laos; RID, Thailand	(a-b) Apply and testing to TC members (c) requirement analysis and gathering TC Members' opinion (d) Establish the modification plan of EFFS		HRFCO, ME
KRA 1 KRA 2 KRA 3 KRA 4 KRA 5 KRA 7	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	RID, Thailand; DID, Malaysia; MHA, Vietnam; PAGASA, Philippines	(a) Parameter optimization for the pilot studies in Malaysia, Philippines, Vietnam and China; and Project workshop online or offline(tbd) (a-c) Trial operation of real-time flood forecasting of the pilot studies in Malaysia, Philippines, and China (d) Project conclusion workshop	8000	SYS Uni.
KRA 3 KRA 6	5	Impact Assessment of Climate Change on Water Resource Variability in TC Members	Application of RCCC-WBM model at selected pilot catchments		See above	(a) First (b) Second (c) Third (d) Fourth	DID, Malaysia MHD, Laos	(a) training workshops in 2-3 TC countries (b) experiences and lessons of model application to the target TC members (c) guidance on case studies of model application for climate change adaptation	5000	
KRA 1 KRA 2 KRA 3 KRA 4 KRA 5	6	Hydro Risk Watch Project for Life-saving	Promoting to install 3L water level gauge and flood forecasting system in TC Members	WGM	See above	(a) First (b) Second (c) Third (d) Fourth	DID, Malaysia	(a-b) Start test observations (at least six months) to check the accuracy of observation data, operability of equipment, etc. Adjustment of observation accuracy, status of data transfer to the server, and evaluation of observation accuracy.		
KRA 1 KRA 2 KRA 3 KRA 4 KRA 5	7	Flood resilience enhancement through Platform on Water Resilience and Disasters		WGM WGDRR	See above	(a) First (b) Second (c) Third (d) Fourth				

KRA	Objective Number	Objective	Action	Other WGs Involved	TCS Responsibility	Expected Quarter Completed	Other Organizations Involved	Success Indicators	Funding Required	Funding Sources
KRA 1 KRA 2 KRA 3 KRA 4 KRA 5	8	Training Course on Hydrological Monitoring and Flood Management for Developing Countries	Enhancement of capacity building of TC Members on flood monitoring and forecasting		See above	(a) First (b) Second (c) Third (d) Fourth		(d) A two-week training course on-line or off-line in October/November	3000	NIHWA
KRA1 KRA3 KRA4 KRA5	9	SSOP-III			See above	(a) First (b) Second (c) Third (d) Fourth	AWG WGM WGDRR			

- KRA 1: Enhance capacity to monitor the impacts of tropical cyclone related disasters, including reduction of mortality rates and direct economic losses, and strengthen tropical cyclone related disaster risk reduction (DRR) activities in various sectors.
- KRA 2: Enhance capacity in tropical cyclone forecast and disaster risk prediction using multi-hazard impact-based forecasts, risk-based warnings, understandable information designed in collaboration with users, and cutting-edge information technology, leveraged from the latest advances in big data analytics, artificial intelligence, machine learning, and social science to support early warning systems, decision making and disaster response.
- KRA 3: Improve flood mitigation measures and integrated water resource management to reduce the impacts of flooding caused by tropical cyclones.
- KRA 4: Strengthen capacity development activities in meteorology, hydrology, DRR and civil protection sectors, to enhance nationally to locally coordinated mechanisms for tropical cyclone early warning information to reach the last mile; and combine public awareness with the appropriate response to protect life and property from tropical cyclones.
- KRA 5: Promote visibility and enhance Typhoon Committee's Regional and International collaboration mechanisms to build partnerships, enhance capacity development, share best practices, and encourage active participation of international organizations in the disaster risk reduction programmes.
- KRA 6: Create a framework for cooperative scientific research on tropical cyclone and related disciplines, particularly in relation to climate change, and include support for translating research outcomes to services by developing relevant experiments, research projects, conducting field surveys, and publishing and promoting research findings.
- KRA 7: Enhance the resilience of vulnerable communities, especially coastal communities, to tropical cyclone impacts.

