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**WORKING GROUP ON HYDROLOGY (WGH)
ACTIVITIES PROGRESS REPORT 2024**

(For TC 19th IWS)

Drafted and Submitted by WGH

(Draft)

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13 November 2024

I. ORGANIZATION OF WGH 13th WORKING MEETING

1. Referring to the decision of the 56th Session of the ESCAP/WMO Typhoon Committee (TC), the Information Center (IC) of the Ministry of Water Resource (WMR), China in cooperation with Nanjing Research Institute of Hydrology and Water Conservation Automation (NIHWA) hosted the 13th working meeting of TC Working Group on Hydrology (WGH) in Nanjing, China on 22-24 October 2024 with the generous offer of funding support.
2. The theme of the meeting was proposed as “**Strengthen Standardization for Better National Hydrological Services**” with the following purposes:
 - to review and present the status, achievements and progresses in hydrological components in Members in 2024;
 - to review the implementation status and progresses of WGH Annual Operating Plans (AOPs) in 2024;
 - to propose the implementation plans and success indicators for WGH AOPs for 2025, including budget requirement from TCTF;
 - to discuss the preparation and hydrological contribution to prepare the 19th Integrated Workshop to be held in Shanghai, China, and TC 57th Annual Session 2025 to be held in Manila, Philippines.
3. Taking the advantage of getting together, China, in cooperation with Typhoon Committee Secretary (TCS), organized one day technical seminar following the working meeting on innovative technology application in hydrological monitoring, forecasting and early warning on 24 October 2024.
4. The working meeting was chaired by Mr. Mamoru MIYAMOTO, and attended by more than 70 participants in total from 9 out of 14 Members of the Typhoon Committee, namely: China; Japan; Lao People’s Democratic Republic (Lao PDR); Malaysia; the Philippines; Republic of Korea; Singapore; Thailand; and USA. Typhoon Committee Secretariat (TCS) also participated in the meeting in person.
5. At opening ceremony, Dr. LIU Zhiyu, Deputy Director-General of Hydrology Department of Ministry of Water Resources; Mr. DAI Jiqun, President of Nanjing Hydraulic Research Institute delivered their speeches. The message from the Secretary-General of Typhoon Committee Dr. DUAN Yihong was delivered by TCS hydrologist Dr. Jinping LIU. WGH Chairperson Mr. Mamoru MIYAMOTO gave his speech on behalf of TC WGH.

6. The meeting exchanged the information on **Strengthen Standardization for Better National Hydrological Services**, and invited **four** Keynote speeches **including**:
 - 1) Dr. Kai WANG from Hydrological Bureau (Information Center) of Huaihe River Commission, Ministry of Water Resources, China presented an overall introduction of China's hydrological information and forecasting standards, with a focus on the overall requirements, forecasting model & methods, forecasting systems, and accuracy evaluation of flood forecasting in China.
 - 2) Mr. MARUYAMA kazuki from the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), Japan and Mr. HIYAMA Hirotaka from Infrastructure Development Institute (IDI), Japan presented standardization efforts at International Organization for Standardization (ISO), various experience and activities of the latest observation technology for hydrological information on water-related disasters, risk mapping for forecasting, and information dissemination mechanisms for early warnings in Japan.
 - 3) Mr. Abdul Hafiz bin Mohammad from the Department of Irrigation and Drainage, Malaysia (DID) presented the Malaysia hydrological standardization is name as Hydrological Procedure (HP) which was first published by the DID in the year 1973. In general, HP can be categorised into 3 main applications:
 - i. Procedures that consist of various hydrological design methods and analysis (i.e. HP1, HP4, HP5, HP11, HP12, HP13, HP16, HP17, HP18, HP20, HP26 and HP27);
 - ii. Procedures that describe various hydrological data collection methods, data management and data quality control (i.e. HP2, HP6, HP7, HP10, HP15, HP19, HP22 and HP28);
 - ii. Procedures related to hydrometric instrument standards (i.e. HP3, HP8, HP9, HP14, HP21, HP23, HP24, HP25, HP32, HP33 and HP35).
 - 4) Dr Hyo-seob Cho, the director general of Geum River Flood Control Office of Republic of Korea (ROK), summarized about the current state of standardization of hydrological information in ROK, highlighting how is it established and its importance of maintaining the hydrological data in good condition in the country. The presentation consists of three major pillars where the first pillar informed about the Hydrologic Unit Map adopted for water resources and flood management in ROK. The second pillar was about the standardization systems, codes, procedures, and practices adopted in ROK for managing the hydrological information. Lastly, Dr. Cho has also demonstrated the procedures, practices, and systems that are being used in ROK currently for monitoring and quality controlling the hydrological data.
7. The participants expressed their highest appreciation to the Information Center (IC) of the Ministry of Water Resource (WMR), China in cooperation with Nanjing Research Institute of Hydrology and Water Conservation Automation (NIHWA) for hosting the WGH 13th working meeting.
8. The meeting was informed with appreciation that MLIT of Japan and Guam, USA will co-host the 14th working meeting for WGH in 2025 in Guam.
9. The meeting also noted with appreciation that Republic of Korea will consider the possibility to host the 15th working meeting for WGH in 2026.

II. The Summary of Member Report on Hydrological Component in 2024

10. The WGH reviewed the flood-related disaster happened in 2024 and hydrological activities conducted in Members in the year, and also noted the special measures took in Members for boosting the capacity of water-related disaster forecasting and early warning.

11. **In 2024, Cambodia...**

12. In 2024, a total of 6 typhoons out of the 18 typhoons generated made landfall in **China**, bringing heavy rainfall to eastern and central China, causing water levels in 468 rivers in 25 provinces of China to exceed the warning level. Among which, Typhoon Kaemi influenced all of seven major river basins in China. Under the influence of Typhoon Kaemi and its residual circulation, four numbered floods occurred in four days from south to north of China, including one in the Han River of the Pearl River Basin, two in the Songhua River, and one in the Yangtze River. The water level of 282 rivers in 21 provinces including Fujian, Guangdong, Hunan, Liaoning, Jilin, Heilongjiang, etc., exceeded the warning level, 78 rivers exceeded the guaranteed level, and even 8 rivers claimed the historical level. Some people died due to the flash flood and landslide caused by Kaemi rainstorm.

To improve the flood forecast accuracy and extend the leading time, China is now implementing the Digital Twin River Basin project, including the strengthen of monitoring and perception from satellites to radars and ground based instruments, research of new water models, construction of water knowledge library, and development of integrated flood decision support systems.

13. **In 2024, DPRK....**

14. In 2024, three tropical cyclones affected **Hong Kong, China**. Super Typhoon Yagi necessitated the issuance of No. 8 Gale or Storm Signal; whereas Tropical Storm Maliksi and Severe Tropical Storm Prapiroon required the issuance of No. 3 Strong Wind Signal and Standby Signal No. 1, respectively.

After a quiet period of tropical cyclone activities over the South China Sea in August, an area of low pressure over the seas east of the Philippines intensified into a tropical depression on 1 September and was named Yagi. Yagi entered the northern part of the South China Sea on 3 September. Under the favorable conditions of very warm sea water and weak vertical wind shear, Yagi rapidly intensified from a severe tropical storm into a super typhoon in just 24 hours on 4 September. Yagi attained its peak intensity with an estimated maximum sustained wind of 230 km/h near its centre in the small hours on 6 September, making it the second strongest tropical cyclone in the South China Sea since the Observatory's records began in 1950. In Hong Kong, there were at least 581 reports of fallen trees, one report of flooding and one report of landslide during the passage of Yagi. A total of nine people were injured.

For hydrological activities, the Drainage Services Department (DSD) has set up a Pilot Smart Flood Alert System at Shing Mun River of Hong Kong. Shing Mun River connects to Sha Tin Hoi and Tolo Harbour. Water level of the river may be affected by storm surges, monsoons and astronomical tides. The cycle tracks and pedestrian walkway along the river may be occasionally flooded. In view of this, DSD has set up the system, comprising display screens and smart poles, next to the four main pedestrian passages near Shing Mun River, and set up QR codes at various

places along Shing Mun River to provide weather and water level information to the public. The display screen and smart poles show real-time water level and images of the river, as well as weather and tidal information from the Hong Kong Observatory. They will also display different messages in response to the change in weather condition and river water level, including "Normal", "Stay Alert", "Warning" and "Danger" mode and let the public to better understand the real-time status of the river.

15. In recent years, the number of occurrences of short-term severe rain with an hourly rainfall exceeding 50 mm has increased in **Japan**. There are concerns that increasing mean sea surface temperatures may increase typhoon damage. The increase in the occurrence of torrential rains and larger typhoons has caused frequent flood damage recently. The effects of global warming are becoming obvious, and water-related disasters are expected to become severer and more frequent in the future due to climate change.

The weather front that began on July 25, 2024 caused record-breaking heavy rainfall mainly in Akita and Yamagata prefectures, and the total rainfall in the Akagawa River basin was 285 mm (about 90% of the normal July rainfall) in two days in many places. In the Akagawa River, riverbed excavation was intensively implemented. In the current outflow, the riverbed excavation reduced the water level by approximately 90 cm, and when combined with the flood control effects of the Gassan Dam, the water level was reduced by approximately 2 m. If the levees had been broken, it is possible that up to 3,900 houses would have been inundated, and therefore, continued river improvement is necessary.

MLIT issued "A Guide to Flood Risk Assessments for Enhanced TCFD (Task Force on Climate-related Financial Disclosures) Disclosures" in March 2024. Private firms are facing the disclosure of climate-related risks, including flood risks, based on the TCFD. This guide proposes a method of evaluating flood risk, in line with the recommendations of the TCFD to support the disclosure activities. Practitioners can assess quantitative future risk easily based on currently-available scientific knowledge. Such disclosure processes are essential to make firms' management more resilient. The proposed flood risk assessment methodology consists of the three phases: (1) Current risk screening, (2) Future risk assessment, and (3) Disclosure. The purpose of the Propose is to share the knowledge on how to check flood risks, and quantitative assessment methodology of future risk.

16. **In 2024, Lao PDR**
17. **In 2024, Macao, China...**
18. In 2024, **Malaysia** was not directly affected by tropical cyclones/storms. Malaysia recorded 783 flood incidents in 2023. Study carried out by Department of Statistics Malaysia found that in year 2023, overall losses due to floods were RM755.4 million (2022: RM1,026.5 million) which equivalent 0.04 per cent (2022: 0.06 per cent) as against nominal Gross Domestic Product. From 1 January to 10 October, 2024, Malaysia has recorded 836 flood incidents. Analysis of the types of flood events shows that 59% are flash floods, while 34% are monsoon floods. Other types include flash floods (5%) and coastal floods (1%). The three main causes of flooding that have been identified are due to continuous heavy rain (39%), overflowing river water (28%), and internal drainage problems (13%).

Malaysia hydrological standardization is name as Hydrological Procedure (HP) which was first published by the Department of Irrigation and Drainage, Malaysia (JPS) in the year 1973. In general, HP can be categorised into 3 main applications:

- i. Procedures that consist of various hydrological design methods and analysis (i.e. HP1, HP4, HP5, HP11, HP12, HP13, HP16, HP17, HP18, HP20, HP26 and HP27);
- ii. Procedures that describe various hydrological data collection methods, data management and data quality control (i.e. HP2, HP6, HP7, HP10, HP15, HP19, HP22 and HP28);
- ii. Procedures related to hydrometric instrument standards (i.e. HP3, HP8, HP9, HP14, HP21, HP23, HP24, HP25, HP32, HP33 and HP35)

Since 2015, Malaysia is developing a Flood Forecasting and Warning System under the Program Ramalan dan Amaran Banjir (PRAB) throughout the country. The 15 years project (2015-2030) aims to provide monsoon flood forecast 7 days in advance and early warning flood forecast up to 2 days in advance to the flood related agencies and public. PRAB consists of four main components (detection, forecast, integrated forecast operation system & warning and dissemination) plans to develop flood forecast modelling system for 74 main river basins throughout the country and currently (year 2024) 28 river basins have been completed and operational.

19. In 2024, **Philippine** was directly affected by ten(10) Tropical Cyclones that entered the Philippine Area of Responsibility (PAR) in the months of May (Typhoon Ewinia), July (Tropical Depression PRAPIRDON, Super Typhoon GAEMI), August (Tropical Storm JONGDARI), September (Severe Tropical Storm YAGI, Tropical Storm BEBINCA, Tropical Depression SOULIK, Tropical Storm PULASAN, Tropical Depression 17W, Super Typhoon KRATHON) and lasted til the 4th of October.

Flooding were experienced in different parts of the country during the passages of these events.

Six (6) regions were affected by flooding in several locations of varying magnitude and were reported in May during the passage of Typhoon Ewinia- highest recorded 24hr. rainfall was 196.9 mm in Region 4A, CALABARZON, Luzon. These event started in May 24, 2024 and lasted until May 29, 2024. General Flood Advisories/Flood Information/Bulletins were issued for these regions.

Sixteen (16) regions were affected by flooding in several locations of varying magnitude and were reported in July during the passage of Tropical Depression PRAPIRDON- highest recorded 24hr. rainfall was 81mm in Baler, Aurora, Region 3, Luzon and Super Typhoon GAEMI- highest 24hr rainfall recorded was 323.9mm. at Science garden, Quezon city, Metro Manila, Luzon) These events started on July 19, 2024 and lasted until July 25, 2024. General Flood Advisories/ Flood Information/Bulletins were issued for these regions.

No regions reported flooding occurrences in August during the passage of Tropical Storm JONGDARI- highest recorded 24hr. rainfall was 63.0mm. in Region 10, Mindanao , It entered the area PAR on August 18, 2024 and immediately exited on August 19, 2024 with no significant effects in the country.

Sixteen (16) regions were affected by flooding in several locations of varying magnitude and were reported in September-October during the passages of Severe Tropical Storm YAGI- highest recorded 24hr. rainfall was 258.90mm in Region 5, Luzon, Tropical Storm BEBINCA- highest

recorded 24hr. rainfall was 178.60mm in Region 4B, MIMAROPA, Luzon, Tropical Depression SOULIK- highest recorded 24hr. rainfall was 89.0mm in Region 2, Cagayan, Luzon , Tropical Storm PULASAN- highest recorded 24hr. rainfall was 99.0mm in Region 1, Luzon, Tropical Depression 17W- highest recorded 24hr. rainfall was 174.0mm in Region 3, Luzon, Super Typhoon KRATHON- highest recorded 24hr. rainfall was 207.0mm in Region 1, Luzon . These events started on September 1, 2024 and lasted until October 4, 2024. General Flood Advisories/Flood Information/Bulletins were issued for these regions. A total of 1,926 combined Flood bulletins/Advisories/Information were issued during these events.

These events has also activated the Flood Forecasting and Warning System for Dam Operations (FFWSDO) in coordination with the four(4) major dams operators in Luzon. A total of 169 combined flood bulletin/information for dam releases were issued during these events.

20. In 2024, **Republic of Korea (ROK)** was not directly invaded by typhoons. Of nineteen (19) typhoons were monitored this year (as of 15 October 2024), there were two (2) typhoons that had impacts on the Korean Peninsula, which were Typhoon No.9 JONGDARI and Typhoon No.10 SHANSHAN in the mid of August, but both typhoons did not land as initially expected. Typhoon JONGDARI has caused one (1) casualty and a victim was hurt. However, overall damages were general minimal. Typhoon JONGDARI was recognized as a very rare type of typhoon as it struck lightning with a very strong intensity, which is very rare in South Korea. In particular, as many as 1,300 lightning strikes were observed overnight near Jeollanam Province, the southern region of Republic of Korea.

The reason for less typhoon damage this year, comparing to previous years, is analyzed to be the record-breaking heat wave this summer in Republic of Korea. This summer, the high pressure of the Tibetan high, which was hot and dry, was mainly located in the upper airspace over the Korean Peninsula, while the high pressure of the North Pacific high, which was hot and humid, was mainly located in the middle and lower airspace. As these two high pressures took hold, they influenced the path of typhoons moving northward.

In 2024, the Flood Control Offices of ROK issued the total of 134 flood watches and 38 flood warnings nationwide from July to September. Considering there were 71 and 22 cases respectively compared to the similar period last year, the number of issued watches and warnings have increased this year. Rather than being caused by a flood from typhoons, this is analyzed to be due to heavy torrential rainfall in Jeollabuk Province (located in the southwest), Chungcheong Province (located in the central area), and Gyeongsang Province (located in the southeast) in mid-July.

To response to changing rainfall patterns, fluctuations in discharge, and increased flood risk, the Ministry of Environment (ME) of Republic of Korea is leading the development of AI-based flood management technology and methodology. AI-based flood forecasting strategies and technologies from a mid- to long-term perspective has been introduced in order to promptly, timely and thoroughly conduct flood forecasts up to tributaries and streams across the country. In year 2024, the early flood warning issue locations have been expanding from 75 to 223 (3 times increase) whereby each location is integrated with Long Short-Term Memory (LSTM) deep learning algorithm for flood monitoring and forecasting in interval of 10 minutes.

21. In 2024, **Singapore** was not directly affected by tropical cyclones/storms. However, the presence of strong tropical cyclones may bring dry air masses from the Indian Ocean or the Java Sea and suppress the development of rain clouds, leading to fair and warm weather conditions over Singapore. In the second half of July 2024, Singapore experienced a dry spell of 18 days between 13 and 30 July 2024. [Note: A dry spell is defined as a period of at least 15 consecutive days with

daily total rainfall of less than 1.0 millimetre (mm), averaged over islandwide stations with long-term records.] During this period, the intensification of Severe Tropical Storm Prapiroon (19-24 July) and Super Typhoon Gaemi (19-29 July) induced a strong cross equatorial flow dominating the maritime continent. Consequently, Singapore experienced persistent dry weather conditions. Many areas across the island registered well below average rainfall in the 2nd half of July. Singapore also updated on the progress of the KRA in hydrological monitoring and flood management. In addition, Singapore shared about the KRA in the following regional activities, which had contributed to Southeast Asia's capability building in the area of extreme weather: (i) ASMC – WMO Regional Forum 2024, (ii) Southeast Asia Regional Climate Centre Network (SEA RCC-Network), (iii) ASEAN Climate Outlook Forum (ASEANCOF), and (iv) Subseasonal-to-Seasonal Predictions for Southeast Asia (S2S-SEA); as well as (v) the release of Singapore's Third Climate Change Study (V3) findings, which MSS is making available the data and findings of V3 to ASEAN member states, in supporting of the scientific understanding and prediction of climate change and its impacts within the Southeast Asia region.

22. In 2024, only one tropical cyclone named “SOULIK” directly attacked **Thailand** in September 2024 causing heavy rain in the northeastern region of Thailand. Additionally, three other tropical cyclones (‘MALIKSI’ from May to June 2024, ‘PRAPIROON’ in July 2024, and ‘YAGI’ in September 2024) in the South China Sea and western North Pacific affected rainfall in Thailand is strengthening caused the flood occurred in 58 provinces in Thailand. There are more than 120 hydrological observation stations was affected.

SOULIK weakened into an active low-pressure cell over upper northeastern Thailand. Its remnant low-pressure cell continued moving slightly westward, covering upper northeastern and lower northern Thailand. This tropical cyclone caused plentiful rainfall, resulting in widespread and heavy rainfall in numerous areas of northern and northeastern Thailand from 19 to 20 September. From the factors mentioned above causing the Ping River basin area which is in the northern part of Thailand, there is a large amount of runoff accumulating in the river basin, resulting in water overflowing the banks in Chiang Mai Province (Ping River at P.1 Station, Mueang District, Chiang Mai Province, 24-28 Sept. 2024, P.81 San Kamphaeng District, Chiang Mai 24-29 Sept. 2024) As 31 October 2024, the amount of water storage in 35 large-scale reservoirs is 83% of their capacity or 59,077 MCM. The water-use volume for dry season is 35,539 MCM that about 2,855 MCM. more than year 2023.

23. The year of 2024 is a very quiet year for the region of **Guam, USA** regarding tropical cyclones, but not record-breaking. The beginning of the year began with significant drought across much of Micronesia, with the third-driest record for multiple islands in FSM for the month of March in the entire 73 years of record keeping. This resulted in multiple critical water shortages that required intervention from various agencies to minimize human suffering. As of September 2024, no issues with water supply across the region as rainfall amounts normalized. Most of the flash flooding events that occurred this year still remained to be TC related, both directly and indirectly. Some of TCs that developed in Guam's AOR October 1, 2023 thru September 30, 2024 caused hydrologic impacts, including: (1) STY Bolaven (15W), with direct impacts: two hydrological outlooks, four flash flood warnings, and indirect impacts: five flood advisories, two flash flood warnings. (2) TY Bebinca (14W) formed near 00Z (10:00 am ChST) Sep 10, 2024, with direct Impacts: one hydrologic Outlook, five flood advisories, two flash flood warnings, and indirect impacts: strongest monsoon surge over Marianas in years; one flood watch, three flood advisories, one flash flood warning, and 8 to 12 inches of rainfall (20-30cm). (3) TY Pulasan (15W), with indirect Impacts:

three flood advisories, two flash flood warnings. With various TC and non-TC related flood events throughout the year, the total amount of rainfall so far through September 30, 2024 is 71.60 inches (182.9 centimeters), just shy of the normal value of 71.80 inches (182.4 centimeters).

24. In 2024, **Vietnam** have been facing a "dragon" year with many abnormal and severe disasters. The prominent disaster situation related hydrology in Vietnam can be mentioned as below:

- In the Northern part, severe flooding occurred in the most of Northern Viet Nam's provinces as results of Typhoon Yagi, in which, flood peaks were recorded in several rivers over historical flood. Flash floods and landslides are dangerous hydrological phenomena that have taken place in the northern mountainous areas.
- In the Central and Highland areas of Viet Nam, as a result of long time lacking of rainfall, drought and water shortage situation occurred during the months of 2024 dry season. However, when the flood season in the Central region has come, the first flood event in the Central of Vietnam is a major flood with the flood peak on many rivers were reached or over flood stage as the result of storm SOULIK appearance.
- In the Southern part, saline intrusion in the Mekong delta area always occurs in every dry season. The severity of saline intrusion will depend on the situation of the upstream Mekong flow.

III. Progresses of WGH AOPs in 2024 and Implementation Plan for 2025

25. The project leaders and/or their representatives from China, Japan, RO Korea presented the progresses in 2024 and the implementation plan for 2025. The participants reviewed and discussed the implementation status in 2024 and the success indicators for 2025 of WGH AOPs.
26. The WGH AOPs in 2024 and beyond was summarized in the table 1. The implementation status of WGH AOP 2024 is summarized in the Annex 1.

Table 1 The list of WGH AOPs in 2024 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	2018~2024
AOP5	Impact Assessment of Climate Change on Water Resource Variability in TC Members	China	2018~2024
AOP6	Flood Risk Mapping with Ground/Satellite Observation Data	Japan	2024~2027
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

AOP1: Knowledge Sharing on Storm Surge Inundation Modeling

27. The implementation plan of the project for 2024 was approved at TC 56th Session as blow:

- pilot study in 4 Members in China; Macao, China; Philippines and Thailand;
- Training course in WMO RTC Nanjing, China in September/October 2024 in conjunct with 13th WGH working meeting.

28. The leader of this project Mr. Edwin Montvila from National Weather Service (NWS), Weather Forecast Office (WFO) Guam informed the implementation status and progresses in 2024 as follows:

- The Pacific Ocean Storm Surge Inundation Model (POSSIM) has been upgraded to a third iteration, utilizing the same algorithms with much more optimized calculation technique to minimize processing overhead. The new iteration is nicknamed “Pascal’s Snail,” or “Limacon.”
- POSSIM now has two extensive user guides attached to it, for intuitive implementation and usage. One is a focal point user guide, designed for main focal points in the respective countries to follow, for implementation of POSSIM in their localized areas. The standard user guide is designed to explain the technical operation, expected behavior and act as a user manual for focal points and non-focal points to utilize POSSIM after setup. This helps to further ease the implementation of POSSIM by TC members in their respective countries.

29. The implementation plan of the project for 2025 was proposed for approval at TC 57th Session as below:

- The Members that are participating in the pilot study now have the toolset and guidance to implement POSSIM in their respective countries for further research and development.
- The Members now have a direct way of tracking, communicating, and updating their version of POSSIM through various means in tandem with guidance from the project leader.
- Localization time highly depends on local resources, data access and research expertise. USA would like to propose to TCS to extend AOP1 by another year, to 2026. This would provide the TC members in the pilot study enough time to run extensive simulations of past and current storms, in addition to communicating any issues in implementation and operation of POSSIM to project lead for further improvement of POSSIM.
- To conduct 2/3-day training workshop in October 2025 in conjunction with WGH 14th working meeting.

30. Referring to the status of the implementation, Guam USA would like to extend this project as AOP of WGH one more years to 2027.

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

31. The proposed activities/implementation plan for the project in 2024 which was approved at TC 56th Session was 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.
32. The implementation status and progresses of the project achieved in 2024 were described as:
- Tested and applied the quality control system in 4 pilot target TC Members (Malaysia, Lao P.D.R, Thailand, Philippines) and gather the user's demands
 - Finished the development of PC-version hydrological data quality control system with Python Program and be developing the AI module and to report in AOP workshop and 19th IWS
 - HRFCO, in cooperated with KICT and DMH, hosted the technical workshop regarding to using AI technique of hydrological data quality control and flood forecasting on 07-08 Nov. 2024 in Vientiane, Lao P.D.R
 - the draft technical report of hydrological quality control using AI will be submitted on Nov. 2024 and to be published at 57th Session.
33. The implementation plan of the project for 2025 was proposed for approval at TC 57th Session as below:
- To conduct application and practical testing in 4 pilot target TC Members (Malaysia, Lao P.D.R, Philippines, Thailand) with final version of hydrological data quality control system
 - To modify the AI hydrological quality control system

AOP3: Improvement of Flood Forecasting Modelling by Using AI Technology

34. The proposed implementation plan of the project for 2024 which was approved at TC 56th Session was described as below:
- To develop and select the suitable AI technologies (Deep-Learning Technology) for flood forecasting
 - AI technologies can directly simulate the flood stage with training the historical rainfall couple with stage data sets
 - To launch the development of flood forecasting system
35. The implementation status and progresses of the project achieved in 2024 were described as:
- Tested and applied the AI flood forecasting technique in 4 pilot target TC members (Malaysia, Lao P.D.R, Thailand, Philippines) and gather the user's demands
 - Selected AI deep-learning flood forecasting technique and establish of development plan of AI forecasting module

- HRFCO, in cooperation with KICT and DMH, hosted the technical workshop regarding to using AI technique of hydrological data quality control and flood forecasting on 07-08 Nov. 2024 in Vientiane, Lao P.D.R
 - The draft technical report of flood forecasting using AI will be submitted Nov. 2024 and to be published at 57th Session
36. The implementation plan of the project for 2025 was proposed for approval at TC 57th Session as below:
- To conduct application and practical testing in 4 pilot target TC Members (Malaysia, Lao P.D.R, Philippines, Thailand) with AI deep-learning technique for flood forecasting
 - To develop the AI flood forecasting system

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

37. The project on OSUFFIM Phase-II: Extension of OSUFFIM (Development Operational System for Urban Flood Forecasting and Inundation Mapping) Application in TC Members was launched officially at TC 50th Session in 2018. The request from by Malaysia team to extend OSUFFIM-II one more year (to TC 57th Session, early 2025) for fulfilling its expected goals entirely was approved at TC 56th Session. This project will be officially closed at TC 57th Session in early 2025, and will be placed by a new project proposed from China.
38. The proposed Implementation plan in 2024 for this project which was approved at TC 56th Session was described as below:
- to further polish the model parameters of the Chinese pilot studies, and trial operate the real-time flood forecasting system.
 - to calibrate the rating curve of Malaysia pilot study and improve the model parameters, set up the real-time flood forecasting system and trial operate it.
 - to improve model parameters for the pilot studies in Philippines, and in Vietnam if needed.
 - to organize a training workshop in Malaysia for Penang river pilot study in 2024.
 - to organize the conclusion workshop in Guangzhou in the end of 2024.
39. The project leader Prof. CHEN Yangnbo from Sun Yat-sen (SYS) University reported the implementation status and progresses in 2024 as:
- Model parameters in Chinese pilot studies have been further optimized, and the models have been used in China for real-time flood forecasting.
 - AI model has been developed for Malaysia and Chinese pilot studies to forecast flood water level in the case that only water level is measured and the rating curve is not steadily available.
 - Study has been carried out in Chinese pilot studies for the flood strengthening effect, and it has been found that urbanization enlarges flood peak flow.
 - OSUFFIM Training workshop for OSUFFIM-II- Pilot Study in Penang, Malaysia was held on 25-27 October 2024.

- The final conclusion workshop has been planned to be held in Guangzhou later this year or early next year, SYS University will provide funding to invite 6 participants from the Members involved in AOP4, namely Malaysia, Philippines, Thailand, Vietnam and Laos.
40. Prof. CHEN Yangbo also generally briefed the main achievements of OSUFFIM in its entire implementation period as:
- Field survey in 5 participating Members
 - Flood forecasting models and flood forecasting systems for Chebei watershed, Buji watershed and Modaoxi watershed of the Chinese pilot studies has been set up and put into trial operation.
 - Flood forecasting models for Penang watershed of Malaysia pilot study and Matina watershed of Philippines pilot study has been set up.
 - Journal papers for the modeling work of Chebei watershed, Pinang watershed and Matina watershed have been published.
41. The participants from OSUFFIM participating Members expressed highest appreciation to Prof. CHEN Yangbo and his team for the remarkable contribution to TC Members on urban flood forecasting and inundation mapping.

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

42. The project on Impact Assessment of Climate Change on Water Resource Variability in TC Members was launched officially at TC 50th Session in 2018. It will be officially closed at TC 57th Session in early 2025, and will be replaced by a new project proposed from China.
43. The proposed implementation plan of the project for 2024 which was approved was described as below as below:
- To organize face to face training workshops in 2-3 TC Members (approximately 4-5 days in total). Training workshops will focus on (1) Global data resources and data fusion, and (2) Model calibration and application.
 - To provide technical assistance to TC Members with capacity building of climate impact assessment on water resources in their countries, if needed.
 - To provide technical support to TC Members on water management policy reports to the Government with addressing climate change.
 - To summarize all the work and experiences of AOP 5 and share the knowledge.
44. The project leader Dr. WANG Guoqing from Nanjing Hydraulic Research Institute (NHRI), China reported the implementation status and progresses in 2024 as:
- Planned to organize the online training workshops for all TC Members in November 2025.
 - Communicated with TC Members for providing technical assistance on capacity building of climate impact assessment on water resources in their respective countries.
 - Communicated with TC Members for providing technical supports on water management policy reports to the Government with addressing climate change.

45. Dr. WANG Guoqing also generally briefed the main achievements of this project in its entire implementation period as:
- Developed a RCCC-WBM model and applied the model to selected TC Members for assessing climate change impact on water resources.
 - Published an ESCAP/WMO technical report entitled “RCCC-WBM model and its application for impact assessment of climate change on water resources variability”.
 - Organized the training courses to TC Members on RCCC-WBM application.
 - Provided technical supports on (1) capacity building with addressing to climate change and guaranteeing water security, and (2) water management policy reports to the Government with addressing climate change.
46. The participants from the participating Members expressed highest appreciation to DR. WANG Guoqing, Prof. YANG Qinli from University of Electronic Science and Technology (UEST) of China and their teams for the remarkable contribution to TC Members on impact assessment of climate change on water resource variability.

AOP6: Flood Risk Mapping with Ground/Satellite Observation Data

47. The objective of this project is to create flood risk maps (FRM) that show the potential and frequency of inundations in target areas in participating TC Member so that to increase the capacity on flood-related disasters risk reduction. The expected outcomes is to enhance the capacity of TC Members for handling of ground observation data and satellite data for assessment of flood risk appropriately, which aligns with KRA2 of TC Strategic Plan and contribute to UN EW4All Pillar of “Detection, observation, monitoring, analysis, and forecasting”. It was officially launched at TC 56th Session in early 2024.
48. The proposed implementation plan for this project in 2024 which was approved at TC 56th Session was described as blow:
- To select the participating Members and pilot river basins.
 - Commencement of the study, determination of target river basin(s), consideration of the methods, data collection and other preparatory works
49. The project leader reported the implementation status and progresses in 2024 as below:
- The Lower Pasak river basin as a target study site was chosen by recent frequent floods.
 - RRI (Rainfall-Runoff-Inundation) model is used for run off and inundation analysis. Dam and weirs will be modeled in the RRI model. 2021 flood inundation area is used for model validation.
 - All necessary data, Dam, Rainfall, Water Level, Discharge, River Cross-Section Survey Results, Inundation Map, Land Use and Elevation, have been collected.
 - Flood mapping by flow scale based on the validated model will be developed..
50. The implementation plan of the project for 2025 was proposed for approval at TC 57th Session as blow:
- To improve flood mapping by flow scale.

AOP7: Flood Resilience Enhancement through Platform on Water Resilience and Disasters

51. The proposed implementation plan of the project for 2024 which was approved at TC 56th Session was described as below:
- to improve the OSS-SR in Davao City and initiate to deploy it in other cities and countries
 - to design the Facilitators' cascaded training to various target audiences in local society
 - to develop cross-sectoral and consolidated governance for water management among relevant stakeholders in Thailand
52. The project leader reported the implementation status and progresses in 2024 as below:
- The hydrological data is shared in real-time through the authorized server connection. The real-time data is displayed and used for hydrological simulation in the OSS-SR.
 - The Multi-stakeholder Consultation Workshop was held in August to design the training program in Davao City, Philippines. Online training of introductory lectures was held using OSS-SR at the end of August.
 - The Platform on Water Resilience and Disasters was successfully launched on March 25, 2024. The kick-off meeting gathered 81 participants from 16 agencies. The implementation plan is discussed among members of the Platform.
53. The implementation plan of the project for 2025 was proposed for approval at TC 57th Session as below:
- Develop the agreed implementation and action plans of the Platform together with relevant stakeholders
 - Conduct data integration and inventory of modeling for Online Synthesis System for Sustainability and Resilience

AOP8: Training Course on Hydrological Monitoring and Flood Management for Developing Countries

54. The proposed implementation plan of the project for 2024 which was approved was described as below:
- To apply for the 4th Training Course Flood Control and Early-Warning and Forecasting and Hydrological Monitoring for Developing Countries in 2024
 - To conduct the 4th training course as a face-to-face gathering in September 2024 at NIHWA in Nanjing, China.
 - To strengthen international exchanges and cooperation, truly embed our own development in global development, achieve mutual benefit and win-win cooperation in benign interaction with other countries under the support of Typhoon Committee Secretary.
 - to compile and share the training materials with TC Members. The edited training materials may be published as TC publications in future.
55. The project leader reported the implementation status and progresses in 2024 as below:
- From June 10th to 14th, 2024, the 78th Executive Council of the World Meteorological Organization (WMO) was held in Geneva, Switzerland. The General Assembly deliberated and approved the application of NIHWA and YZU to jointly establish the WMO Regional Training Center for Hydrology (WMO RTC). The center is the first WMO regional training

center in the field of water conservancy and hydrology in China and the third RTC in China. It will play an important role in further improving China's hydrometeorological service capacity and promoting international cooperation.

- The face to face training class will be comprised by three main parts: lectures, study tours, and cultural experience. The training course is mainly convened to allow participants to learn about China's hydrological monitoring technology, acquire general ideas on how to apply the automatic system of hydro-meteorological data observation and transmission, and have further cooperation between participating countries and China.
 - More and more participating countries come from Typhoon Committee Member countries will join the training class.
 - There will be a wide spread of participation through different countries and more and more countries pay attention to the training course under the influence of NIHWA-YZU (WMO RTCs).
 - The training course has been well received by the students, and the efforts of the training team and relevant departments have been fully affirmed in previous training.
56. The implementation plan of the project for 2025 was proposed for approval at TC 57th Session as blow:
- Apply for the 5th Training Course Flood Control and Early-Warning and Forecasting and Hydrological Monitoring for Developing Countries in 2025. At the same time, as NIHWA-YZU (WMO RTCs) was designated in the 78th session of the WMO Executive Council 2024, it will provide continuous training and education in the field of hydrology for WMO members, aiming at improving the professional ability of hydrology and related sciences.
 - By building a professional training center and carrying out a series of training work, the on-going training will enhance the technical ability and professional level of China and other developing countries in the fields of hydrological forecasting and flood control early warning and forecasting, and contribute China's strength to Typhoon Committee members and global water resources management, flood control and disaster reduction and cooperation.
57. Referring to the status of the implementation, China-side would like to extend this training course as AOP of WGH three more years to 2028.

AOP9: SSOP-III

58. The project on Synergized Standard Operating Procedures for Coastal Multi-Hazard Early Warning System (SSOP)-Phase III with 3 years period from 2023 to 2025, led by USA, was launched officially at TC 55th Session.
59. The representative of the project leader reported the implementation progresses of the project in 2024 as blow:
- To re-writing the proposal based on the comments from ESCAP and submit the updated proposal to ESCAP for approval.
60. The project leader reported the implementation status and progresses in 2024 as below:
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61. The implementation plan of the project for 2025 was proposed for approval at TC 57th Session as below:
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New AOP4: Review and enhancement on specifications for hydrological information and forecasting in TC Members

62. With the impact of global climate change and human activities, the situation of water related phenomena has become more complex and changeable in recent years, and rainstorm, flood, drought, salt tide and other water-related disasters have become increasingly sudden, extreme and abnormal. The current problem of flood risk in small and medium-sized rivers and reservoirs is becoming increasingly prominent. The technical standards and operating instructions is the basis of all hydrological activities, which play an very important role to establish a standard operational procedure for instrument and equipment installation and operation, hydrological data observation, processing and analysis, archiving and dissemination, and so on. Most TC Members have established their standard system according to their actual situation for hydrological information and forecasting. Some Members have established a fairly well-developed system of technical standards, such as China, Japan, Republic of Korea, Malaysia, etc. However, in some Members, the system of specifications and technical standards for hydrological information forecasting is not particularly perfect yet. In this context, China is willing to propose “**Review on specifications for hydrological information and forecasting in TC Members**” as one of WGH AOPs in 2025 and beyond with the goal of improving the capacity of standardization of hydrological information and forecasting for better national hydrological services in TC Members.
63. The objective of proposal is to (1) review and assess the status of standardization of hydrological information and forecasting in TC Members; (2) to exchange and share the knowledge and experiences on specifications of information and forecasting among TC Members; and (3) to put forward a guidance recommendations on promoting the specifications for hydrological information and forecasting for TC Members, as the output of the proposal.
64. The proposed AOP will last 3 years from 2025 to 2027 with a road-map as below:
- 2025: Kick-off of the AOP, developing a detailed work-plan with involved TC Members, and conducting literature review, field survey with involved members & gathering their opinions;
 - 2026: field survey with involved members & gathering their opinions, drafting the new normative technical documents for hydrological information and forecasting and solicit opinions from all TC members;
 - 2027: Drafting the review report, finalizing the normative technical documents, and sharing with TC members. .
65. The implementation plan of the project for 2025 was proposed for approval at TC 57th Session as below:
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New AOP5: Application Study on New Generation of Integrated Micro-siphon Rain Gauge in TC Members

66. In recent years, natural disasters, especially hydro-meteorological disasters, have occurred more frequently around the world, and extreme weather and climate events have seriously threatened people's lives and property safety and regional economic development. According to the Emergency Disaster Database (EM-DAT), the total number of rainstorm and flood events in Asia has increased from 303 in 1970-1980 to 1,541 in 2011-2020, and the total number of drought events has increased from 85 to 152. According to statistics, over the past 50 years, there has been one disaster event related to extreme hydro-meteorological phenomenon every day on average, causing 115 deaths a day and \$202 million in economic damage. In order to reduce disaster losses, it is necessary to upgrade real-time monitoring and early warning, and to strengthen scientific research and judgment on aspects of the occurrence time, intensity, change trend and affected area of disasters, so as to improve the precision and timeliness of forecasts. In this context, the Nanjing Research Institute of Hydrology and Water Conservation Automation of the Ministry of Water Resources, China has devoted many years to the improvement and upgrading of hydrological monitoring instruments and equipment. China intends to share its experience and knowledge with TC Members on the integrated micro-siphon Rain Gauge with high precision and resolution in rainfall monitoring and forecasting. Therefore, **Application Study on New Generation of Integrated Micro-siphon Rain Gauge in TC Members** as a new AOP of WGH.
67. The objective of the proposed AOP is to carry out the promotion and application of integrated micro-siphon Rain Gauge with high precision and resolution in TC Members, so as to (1) enhance the efficiency of early warning of rainstorm disasters, and (2) provide early warning of disasters for the public, provide basic data support for the government to implement disaster prevention and reduction decision-making and deployment, and reduce disaster losses.
68. The expected outcomes of the proposed AOP is knowledge sharing and application of **New Generation of Integrated Micro-siphon Rain Gauge in TC Members so as to upgrade the capacity building of rainstorm and flood disaster risk reduction rainstorm of TC Members through enhancement of real-time monitoring and analysis.**
69. The micro-siphon rain gauge with integrated design, integrated power supply and data acquisition, transmission module, suitable for harsh natural environment applications. The siphon effect not only improves the observation accuracy of the rain gauge, but also enhances the stability of the equipment. The main advantages are as follows:
 - Rainfall resolution: 0.1mm, can measure the rain day (daily rainfall $\geq 0.1\text{mm}$ to determine that there is rain on the day)
 - Time resolution: $< 1\text{s}$, which can easily calculate the rainfall intensity and rainfall duration at any time
 - Amount of accuracy: $\pm 2\%$
 - Intensity range: $\leq 6\text{mm/min}$
 - Dual channel communication: 4G and Beidou satellite
70. The proposed AOP will be lasted 3 years from 2025 to 2027 with a road-map as below:

- 2025: to initiate the field pilot study in China; to organize the field workshop in China for the selected Members.
- 2026: to initiate the field pilot study in the selected Members.
- 2027: to conduct the comparison analysis and to summarize the application study.

71. The implementation plan of the project for 2025 was proposed for approval at TC 57th Session as below:

- 1st Quarter, 2025: (1) to collect participating Members and select demonstration application areas; (2) to work out the preliminary implementation plans, and formulate follow-up work arrangements.
- 2nd -3rd Quarter, 2025: to conduct application study in China, including collecting typhoon heavy rainfall observation literature data, carrying out theoretical analysis and experience summary, analyzing the problems existing in the installation, operation support and collaborative observation of observation equipment, study solutions, and determine the follow-up installation and operation plan of equipment.
- 4th Quarter, 2025: conduct training on the new generation of integrated Micro-siphon Rain Gauge for participating Members.

Summary of WGH AOPs in 2025 and Beyond

72. The WGH AOPs for 2024 and beyond were listed in Table 2, and the success indicators of AOPs for 2024 are shown in Annex 2.

Table 2: The list of WGH AOPs in 2025 and beyond

Item	Projects	Driver	Duration
AOP1	Knowledge Sharing on Storm Surge Inundation Mapping	USA	2020~2026
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	Review and enhancement on specifications for hydrological information and forecasting in TC Members	China	2025~2027
AOP5	Application Study on New Generation of Integrated Micro-siphon Rain Gauge in TC Members	China	2025~2027
AOP6	Flood Risk Mapping with Ground/Satellite Observation Data	Japan	2024~2027
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	2023~2028
AOP9	Synergized Standard Operating Procedures for Coastal Multi-	USA	2023~2025

	Hazard Early Warning System (SSOP)-Phase III		
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IV. Technical Seminar on Innovative Technology Application in Hydrological Monitoring, Forecasting and Early Warning

73. Taking the advantage of getting together, China, in cooperation with Typhoon Committee Secretary (TCS), organized one day technical seminar following the working meeting on innovative technology application in flood related disaster forecasting and early warning on 24 October 2024. more than 40 participants in total took part in this Session.
74. Dr. ZHONG Hua from Nanjing Hydraulic Research Institute (NHRI) introduced how to deal with flooding induced by Typhoon via the management of dam operation. He introduced the optimal dam-operation methods for coping with flooding in detail, including hydrological data observation, hydrological models for flood forecasting, scheduling models and decision support systems. He presented the technical case studies of the dam operation system in Changjiang river (large river basin) and in Puyangjiang river (small river basin), respectively. Dr. ZHONG also briefed the Digital twin technology and 1D/2D Hydrodynamic Model which are applied to estimate the impact of flood risk induced by dam operation with large discharge releasing.
75. Mr. FANG Weihua from Nanjing Research Institute of Hydrology and Water Conservation Automation (NIHWA) introduced the adaptability assurance development & application of hydrometric measurement equipment under disastrous weather conditions. Mr. Fang presented the achievement of the study in recent years on the effects of disastrous weather on hydrometric elements, the operating environment of equipment, and the relevant indicators. He briefed the basic indicators (e.g. accuracy, stability and reliability) and extended indicators (e.g. resistance to flood, wind and rain, electromagnetic impact) of the equipment, which are required for coping with the progressively worsening weather patterns and impacts. He stressed that, the hydrometric equipment must be equipped with all-weather, full-range and full-scenario measurement accuracy, reliability and resistance to damage in order to adapt to the influence of disastrous weather. Mr. Fang shared the experiences of NIHWA on the equipment comparison in all aspects, including the principle of selection, structural optimization, material matching, process improvement, inspection, rate determination and on-site manual operation by making full use of acoustics, radar, optics and artificial intelligence and other latest technologies, etc. He also briefed the improvement for new developed equipment on the principle selection, structure optimization, material matching, process improvement, inspection, rate determination and on-site manual quality control, etc. Those new developed equipment, such as micro-siphon - tipping bucket integrated rain gauge, new type array acoustic ADCP, millimeter-wave surface flow velocity meter, multi-frequency optical sand meter, acoustic-optical fusion sand measurement and multi-frequency acoustic sediment profiler, etc, have been used in practice successful in China.
76. Ms. WNG Yan from Shanghai Huace Navigation Technology Ltd presented Intergated Measurement above and below water. The presentation focuses on the pain points of overwater and underwater data acquisition and fusion, and highlights the application of UAV-mounted LIDAR, USV-mounted multibeam and ADCP in enhancing the modernization of hydrological monitoring. The report focuses on 2 core solutions: acquisition and modeling of high-precision 3D topography over water and underwater, and unmanned collection of hydrological flow data.

Through the implementation of these solutions, a precise and efficient integrated hydrological survey equipment system will be constructed.

77. **Mr. DAI Zailin from iStrong Tech** presented on the topic "The Information Solutions for Urban Waterlogging Monitoring and Response," covering aspects of urban waterlogging monitoring, early warning, simulations, and joint emergency response coordination. The presentation began with an overview of waterlogging issues in China and their associated risks. It then analyzed the various monitoring and management requirements for urban drainage systems during dry and rainy seasons. Based on the analyses, Mr. DAI introduced the IOT-based technology for monitoring urban drainage systems, including monitoring water level, flow, velocity, water quality, and manhole cover status at waterlogging-prone locations, pipelines, and inner rivers. For example, at waterlogging-prone locations, an embedded water level transmitter, utilizing both ultrasonic and pressure sensor, can be used for real-time monitoring to track water levels and transmits data via 4G or NB-IOT. Mr. DAI also briefed innovative AI-based techniques for waterlogging monitoring. Furthermore, He demonstrated how to simulate the impact of disasters, establish joint dispatch mechanisms and issue the information of early warnings for the rapid emergency response based on the monitoring data, technologies such as big data, artificial intelligence, and digital twin systems. Lastly, Mr. DAI showed the case studies of its product applications in countries, such as the Philippines and Finland, etc.
78. **Mr. CAI Guocheng from Anhui Wote Water Science and Technology Co., Ltd.** introduced **Rainstorm Disaster Risk Early Warning Model - Application in Road Traffic Risk Early Warning**. The presentation introduced how to build an efficient, timely and intelligent rainstorm disaster early warning service through space monitoring technology and early warning model, so as to improve disaster response ability, reduce disaster losses and ensure the safety of people's lives and property. The presentation comprehensively covered the following key aspects: the enterprise profile of Waterwater, the in-depth analysis and review of the disasters and the secondary disasters caused by rainstorm, the intelligent early warning model based on the independent-developed rainfall detection radar technology, the diversified risk early warning application scenarios supported by the model, and innovative service initiatives for the public.
79. **Mr. CHEN Li from Guiren Tech** introduced **Water Security Management Based on Digital Twin Technology**. As the frequency of extreme weather events increases globally, the impact of water disasters on human society is gradually growing. In order to overcome the technical limitations of domestic models in the current market, Keepsoft continually enhances the development of its core product. To showcase the ability of water disaster prevention, Mr. CHEN presented one case study in Wuchi Creek Basin, which covers a drainage area of around 100 km² and a river length more than 20 km. To minimize the losses caused flood-related disasters in the future, Keepsoft integrated the GIS data, IoT and basic data in the intelligent system and built 1D/2D hydrodynamic models and the coupling model based on local geographical features, in order to simulate flood risk and predict the potential flood situation along the river. Through the scientific solutions, forecast accuracy has improved by 90% and economic losses has reduced by 60%. To address the reliability of solution, Keepsoft continuously updates its core product, the GRMS hydraulic model, which is comprised of a modeling tool interface, model engine library and cloud service. The engine library covers the entire water cycle. The modeling tool supports rapid processing of data from multiple sources and dynamic interaction. The cloud provides innovative cloud services such as cloud storage and parallel computing. Compared to Mike, GRMS has more comprehensive computing capabilities, resulting in improved calculation speed and accuracy.

V. Review TCTF allocation for WGH AOP activities in 2024 and Proposed Request for 2025

80. WGH reviewed the allocation of TCTF (\$29000USD) for WGH activities and usage (up to September) in 2024 shown in table 3.

Table 4 The summary of TCTF Budget Request for 2024 Activities

Item	Projects	Driver	Budget	Usage
1	Knowledge Sharing on Storm Surge Inundation Mapping	USA	9000	(8000)
2	Improvement of Hydrological Data Quality Control System by Using AI technology	ROK	0	
3	Improvement of Flood Forecasting modelling by Using AI technology	ROK	0	
4	OSUFFIM Phase-II: Extension of OSUFFIM Application in TC Members	China	5000	On-going
5	Impact Assessment of Climate Change on Water Resource Variability in TC Members	China	5000	
6	Flood Risk Mapping with Ground/Satellite Observation Data	Japan	0	
7	Flood resilience enhancement through Platform on Water Resilience and Disasters	Japan	0	
8	Training Course on Hydrological Monitoring and Flood Management for Developing Countries	China	7000	On-going
9	Synergized Standard Operating Procedures for Coastal Multi-Hazard Early Warning System (SSOP)-Phase III	USA	0	
10	Supporting hosting WGH 13 th working meeting in 2024		3000	On-going
	Total		29000	

81. The Participants expressed their highest appreciation to China; Japan; RO Korea; Guam, USA and other Members for their in-kind contribution in the year, and encouraged all Members continue their strong support.
82. Based on the discussion, WGH proposed the budget request of **\$29,000USD** for supporting its activities in 2024 shown in table 4.

Table 4 The summary of TCTF Budget Request for 2025 Activities

Item	Projects	Driver	Budget
1	Knowledge Sharing on Storm Surge Inundation Mapping	USA	10000

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	Review and enhancement on specifications for hydrological information and forecasting in TC Members	China	3000
5	Application Study on New Generation of Integrated Micro-siphon Rain Gauge in TC Members	China	3000
6	Flood Risk Mapping with Ground/Satellite Observation Data	Japan	
7	Flood resilience enhancement through Platform on Water Resilience and Disasters	Japan	3000
8	Training Course on Hydrological Monitoring and Flood Management for Developing Countries	China	7000
9	Synergized Standard Operating Procedures for Coastal Multi-Hazard Early Warning System (SSOP)-Phase III	USA	
10	Supporting hosting WGH 14 th working meeting in 2025		3000
	Total	29000	

VI. WGH Chairmanship

83. 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 Guam, USA serving as Vice-chairpersons for their hard work and contribution in the past two-year term.
84. The participants accepted the nominations from Members on Dr. Mamoru Miyamoto from Japan to continue serving as WGH Chairperson, Dr. CHO Hyo Seob from Republic of Korea, Dr. HOU Aizhong from China, and Mr. Kenneth KLEESCHULTE from Guam, USA serving as Vice-chairpersons to continue serving as Vice-chairpersons for the next two years to TC 59th Session.

VII. Conclusions

85. On the basis of the discussion and outcomes at 13th WGH working meeting, participants recognized the importance in following aspects for further direction of WGH:
- WGH agreed to enhance the AI application research in hydrological information and forecasting in next years.
 - WGH recognized the importance to improve the advanced technology application in hydrological data monitoring and collection, and agreed to propose from China “**Application Study on New Generation of Integrated Micro-siphon Rain Gauge in TC Members**” as one of AOPs in next years.

- WGH recognized that Strengthening the standardization of hydrological information and forecasting is very important to promote the capacity of national hydrological services in Members, so that the theme of WGH 13th Working Meeting was proposed as “Strengthen Standardization for Better National Hydrological Services”. WGH agreed the proposal from China “**Review and enhancement on specifications for hydrological information and forecasting in TC Members**” as one of WGH AOPs in next years.
- WGH noted that some AOPs will be closed in 2025, and call for Members to Members to propose new AOPs for 2026 and beyond.

VIII. Recommendations to the Committee

86. On the basis of the deep discussion and communication, participants agreed to submit the following recommendations to the Committee at TC 57th Annual Session to be held in early 2025:

- to re-appoint Dr. Mamoru Miyamoto from Japan to continue serving as WGH Chairperson, Dr. CHO Hyo Seob from Republic of Korea, Dr. HOU Aizhong from China, and Mr. Kenneth KLEESCHULTE from Guam, USA to continue serving as WGH Vice-chairpersons for the next two years to TC 59th Session.
- to request **US\$29,000** from TCTF for supporting overall WGH activities for 2023 calendar year.
- to thank China for hosting WGH 13th Working Meeting on 21-24 October, 2024.
- to request Guam, USA and Japan to co-host WGH 14th working meeting in 2025 with funding support.
- To Request republic of Korea to consider the possibility of hosting WGH 15th working meeting in 2026 with funding support.
- To approve AOP “Knowledge Sharing on Storm Surge Inundation Modeling” led by Guam USA to extend one more years to 2026.
- To approve AOP “Training Course on Hydrological Monitoring and Flood Management for Developing Countries” led by China to extend three more years to 2028.
- To approve the two proposes from China as AOPs of WGH from 2025 to 2027, namely: (1) Review on specifications for hydrological information and forecasting in TC Members; and (2) Application Study on New Generation of Integrated Micro-siphon Rain Gauge in TC Members.
- To request Members to propose new AOPs for 2026 and beyond.

Annex 1. Implementation Status of WGH AOP 2024

Annex 2. Successor Indicators of WGH AOP 2025

Annex 1. Implementation Status of WGH AOP 2024

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	NIHWA, China; RID, Thailand	(a-d) pilot study in selected Members. (c-d) Training course for selected Member	9000	MWR, China; RID, Thailand; PAGASA, Philippines	On-going YES
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-c) Select AI techniques for HDQCS and testing with TC member data (c) Requirement analysis and gathering TC Members' opinion (d) Confirm the modification plan of hydrological quality control system		KICT, HRFCO, ME	YES On-going YES
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-c) Select AI techniques for EFFS and testing with TC member data (c) Requirement analysis and gathering TC Members' opinion (d) Confirm the modification plan of EFFS		KICT, HRFCO, ME	YES On-going YES
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	DID, Malaysia; PAGASA, Philippines; VMHA, Vietnam	(a-c)To further polish the model parameters of the Chinese pilot studies, and trial operate the real-time flood forecasting system (a-c)To calibrate the rating curve of Malaysia pilot study and improve the model parameters, set up the real-time flood forecasting system and trial operate it (a-c)To improve model parameters of the pilot studies in Philippines, and Viet Nam if needed (d)To organize a training workshop in Malaysia pilot study in later of 2024 (d)To organize the conclusion	5000	SYS Uni. China; DID, Malaysia; PAGASA, Philippines	YES On-going NO On-going On-going

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
								workshop in Guangzhou in the end of 2024			
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-b) help TC Members with capacity building of climate impact assessment on water resources and provide policy report (c) training workshops in 2-3Members (d) summarize all works of AOP5 and share knowledge	5000	NHRI, DID, MHD, RID.	On-going On-going On-going
KRA 1 KRA 2 KRA 3 KRA 4 KRA 5	6	Flood Risk Mapping with Ground/Satellite Observation Data	To collect necessary data at the target river basin		See above	(a) First (b) Second (c) Third (d) Fourth	RID, Thailand; MOWRAM, Cambodia	(a-b) determination of target river basin(s), (a-c) consideration of the methods, (a-d) data collection and other preparatory works at the target river basin(s).		MLIT	Yes On-going On-going
KRA 1 KRA 2 KRA 3 KRA 4 KRA 5	7	Flood resilience enhancement through Platform on Water Resilience and Disasters	To conduct training and launch the Platform in Thailand	WGM WGDRR	See above	(a) First (b) Second (c) Third (d) Fourth	PAGASA, Philippines; RID & TMD, Thailand	(b) Improve the prototyping of the OSS-SR in Davao City, Philippines (c) Deploy the OSS-SR to Digos City, in the Philippines and Thailand (d) Training on flood resilience based on the OSS-SR		ICHARM	Ongoing Ongoing Ongoing
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	NHSs of all Members	(a-d) to compile the training materials as TC publications; (c-d) A two-week training course face-to-face in October/November	7000	NIHWA	On-going On-going
KRA1 KRA3 KRA4 KRA5	9	SSOP-III			See above	(a) First (b) Second (c) Third (d) Fourth	AWG WGM WGDRR	(a-b) re-writing the proposal; (c-d) submit the re-wrote proposal to ESCAP for approval		ESCAP	On-going

- 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 2025

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	NIHWA, China; RID, Thailand	(a-b) have TC Members complete localization of POSSIM in their respective countries. (b-d) have TC Members run simulated and archived storms using historical data and/or bulletins in their respective domains. (b-d) have TC Members continue to update the functionality of POSSIM for their local needs, while coordinating with primary focal point. (c-d) i. complete reports indicating performance, strengths, weaknesses, improvements, and future expectations of POSSIM; ii. to help TC Members improve in interpreting produced data, as well as improve methodology in communicating expected impacts in vulnerable zones in their respective domains; iii. establish criteria for successful implementation as studies continue into 2025, including but not limited to; iv. UI improvement, performance improvement, algorithm improvement, local bias adjustments. v. Training workshop in Oct, 2025	10000	MWR, China; SMG, Macao, China; RID, Thailand; PAGASA, Philippines
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-c) To conduct application and practical testing in 4 pilot target TC Members (Malaysia, Lao P.D.R, Philippines, Thailand) with final version of hydrological data quality control system (d) To modify the AI 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-c) To conduct application and practical testing in 4 pilot target TC Members (Malaysia, Lao P.D.R, Philippines, Thailand) with AI deep-learning technique for flood forecasting (c-d) To develop the AI flood forecasting system		HRFCO, ME
	4	Review on specifications for hydrological information and forecasting in TC Members			See above	(a) First (b) Second (c) Third (d) Fourth			3000	
KRA3 KRA4	5	Application Study on New Generation of Integrated Micro-siphon Rain Gauge in TC Members	To initiate the field pilot study and workshop for selected Members		See above	(a) First (b) Second (c) Third (d) Fourth	PAGASA, Philippines; DID, Malaysia; RID, Thailand	(a) to collect participating Members and select demonstration application areas; (b-c) to conduct application study in China (c-d) to conduct training workshop on the new generation of integrated Micro-siphon Rain Gauge for participating Members.	3000	NIHWA

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	6	Flood Risk Mapping with Ground/Satellite Observation Data	To develop Flood Risk Map at the target river basin		See above	(a) First (b) Second (c) Third (d) Fourth	RID, Thailand; MOWRAM, Cambodia	(a-b) Flood mapping by flow scale based on the validated model (b-d) Developing the final version for Flood Risk Map		MLIT
KRA 1 KRA 2 KRA 3 KRA 4 KRA 5	7	Flood resilience enhancement through Platform on Water Resilience and Disasters	To finalize implementation plan and update the Platform	WGM WGDRR	See above	(a) First (b) Second (c) Third (d) Fourth	PAGASA, Philippines; RID & TMD, Thailand	(a-b) action plan of the Platform agreed with relevant stakeholders (c-d) data integration and inventory of modeling for Online Synthesis System for Sustainability and Resilience	3000	ICHARM
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	NHSs of all Members	(a-d) to compile the training materials as TC publications; (c-d) to provide continuous training and education in the field of hydrology for TC & WMO members, aiming at improving the professional ability of hydrology and related sciences	7000	NIHWA
KRA 1 KRA 3 KRA 4 KRA 5	9	SSOP-III			See above	(a) First (b) Second (c) Third (d) Fourth	AWG WGM WGDRR			ESCAP

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