ESCAP/WMO Typhoon Committee
Fifty-sixth Session of Typhoon Committee
27 February to 01 March 2024
Kuala Lumpur, Malaysia

FOR PARTICIPANTS ONLY
WRD/TC.56/8.1
6 February 2024
ENGLISH ONLY

WORKING GROUP ON TRAINING & RESEARCH COORDINATION GROUP (TRCG) 2023

(Submitted by TRCG Chair)

ACTION REQUIRED:

The Committee is invited to:

a) Take note of the Members activities and major progress and issues in TRCG component in 2023 as reported by Members at the 18th IWS.
b) Review the activities of TRCG conducted in 2023.
c) Approve the recommendations and planned activities of TRCG for 2024 and beyond.

APPENDICES:
A. DRAFT TEXT FOR INCLUSION AT SESSION REPORT
B. Report on activities of Working Group on Training & Research Coordination Group (TRCG) in 2023

APPENDIX A

DRAFT TEXT FOR INCLUSION IN THE SESSION REPORT

7.4. Training and Research Coordination Group

1. The Committee took note of the progress made in training and research activities as presented in the TRCG Report 2023, including the successful completion of the 4th TRCG Forum in conjunction with 18th IWS in Bangkok, Thailand. (Appendix XIII)

2. The Committee expressed its appreciation to WMO and ESCAP for hosting the 4th TRCG Forum.

3. The Committee took note of the planning and recommendations made in the TRCG Planning Meeting held on 30 November 2013 after the 4th TRCG Forum, particularly with respect to the revised priority research and training areas and the formulation of a new 4-year work plan for 2024-2027. The Committee thanked TRCG members for their continuing effort and commitment in support of TRCG initiatives.

4. The Committee thanked Hong Kong, China and Republic of Korea for hosting research fellowship programs in 2023.

5. The Committee took note of the successful RSMC Tokyo training attachment of forecasters in January 2024, and thanked JMA and WMO TCP for continuously supporting this capacity-building initiative.

6. The Committee was informed of the proposed changes with respect to the organization and implementation of future Roving Seminars.

7. The Committee appreciated TRCG's input in support of training and research activities in connection with TC's cross-cutting projects.

RECOMMENDATIONS of TRCG:

8. Based on the discussion in the TRCG Planning Meeting on 30 November 2023 and as presented in the TRCG Report 2023, TRCG recommended the Committee to:

    a. Take note of TRCG Report 2023, including report on the 4th TRCG Forum.

    b. Endorse the priority training and research areas as proposed in TRCG Report 2023.

    c. Approve the changes in the arrangement with respect to the Roving Seminar.

    d. Endorse the TRCG Work Plan for 2024 – 2027.

    e. Endorse TRCG AOP 2024.

Appendix B
TRAINING & RESEARCH COORDINATION GROUP (TRCG)
Annual Report 2023

Anh Tien DO (TRCG Chair)
Vietnam

1. Introduction

1.1 According to the Terms of Reference, TRCG is to promote research and training activities on various aspects of tropical cyclone analysis and forecasting, including assessment of tropical cyclones' impacts on Members' socio-economic development processes, and to encourage cooperation of efforts among Members. Towards this end, TRCG is expected to assist in:

(a) identifying scientific and technical problems in the analysis and forecasting of tropical cyclones and their impacts on water resources and measures for disaster prevention and preparedness;
(b) facilitating the exchange of experience and knowledge on the latest development and techniques related to the above problems;
(c) coordinating training and research programmes, including activities in support of cross-cutting initiatives and other collaboration programmes among Members such as twinning and mentoring arrangement, aimed at improving the technical capacity and capability of Members to better serve the people in the region;
(d) evaluating the effectiveness of training and research activities undertaken by TRCG, and providing support to other working groups in performing such evaluation; and
(e) recommending to the Committee priority areas and long-term plans for cooperation in research and training in support of the targets and various KRAs of the Committee's Strategic Plan.

2. Membership

2.1 The composition and members list of TRCG (as of 27 February 2024) are:

Chair:	Dr Anh Tien DO (Vietnam)
Vice Chair:	Dr Eun Jeong CHA (Republic of Korea)
	Mr CHOY Chun-wing (Hong Kong, China)
Members:	Mr So Im Monichoth (Cambodia)
	Dr QIAN Qifeng (China)
	Mr SONG Yong Choi (DPR Korea)
	Dr ISHIHARA Koji (Japan)
	Dr SHIMADA Udai (Japan)

Dr Mayphou Mahachaleun (Lao PDR)
Mr HO Kuok Hou (Macao, China)
Mr Hamray bin Muhammad Yazit (Malaysia)
Ms Shirley David (Philippines)
Ms Kyungho Lee (Republic of Korea)
Mr Eugene Chong (Singapore)
Mr Tanya Thongnunui (Thailand)
Mr Eric Lau (USA)

3. Major TRCG Activities in 2023

The 4th TRCG Forum / TRCG Planning Meeting

3.1 The 4th TRCG Forum conducted successfully in conjunction with the 18th IWS in ESCAP Conference Center, Bangkok, Thailand during 28 November – 1 December 2023. A physical TRCG Planning Meeting was also convened during the 4th TRCG Forum/18th IWS. A summary report of the forum can be found in Annex I.

3.2 The theme of the Forum was "Towards a typhoon resilient society" during 28 November – 1 December 2023. There were 3 keynote lecture sessions with topic "Artificial intelligence for tropical cyclones related applications", "Special target observation over the western North Pacific" and "Impact based forecasting for tropical cyclones", with 9 invited keynote speakers, including experts from China, Japan, Republic of Korea and Thailand. A special session on UN Early Warning for All (EW4ALL) initiative was also conducted on 28 November with speakers from WMO and ESCAP.

3.3 The Forum was well attended with more than 130 participants from 11 out of the 14 Members of the Committee. The Forum received positive feedback from the participants. They considered that the Forum provided a comprehensive overview of forecasting, warning, monitoring typhoons, and integrating new technologies into operational practices, especially in the context of tropical cyclones, which can be presented in the near future. In particular, the Forum provides up-to-date information on artificial intelligence (AI), ensemble impact based forecasting, disaster risk reduction (DRR) techniques, rapid scan services for monitoring typhoons, ideas related to machine learning, and satellite-based typhoon observation.

Roving Seminar / Visiting Lecturers Programme

3.4 Roving seminars have been arranged for capacity building purposes on both research and operational aspects. Knowledgeable experts travel to Members' countries and deliver lectures focused on subjects of current interest to operational centers. A record of all roving seminars previously organized can be found in Annex II.

3.5 The Typhoon Committee Roving Seminar 2023 was successfully held on 28 – 30

June 2023 in Ha Noi of Viet Nam. The seminar was kindly hosted by the National Hydro-Meteorological Service of Viet Nam. The theme of this seminar was on "Advances in Tropical Cyclone Monitoring and Prediction for Impact Based Forecasting" with speakers of the seminar as follows:

Topic	Speaker
1. TC-induced Rainfall forecasting in Vietnam by using GFS selective ensemble with GSMaP	Assoc. Prof. Dr. Pham Thi Thanh Nga Viet Nam Institute of Meteorology, Hydrology & Climate Change
2. Current estimation, understanding, and forecast of landfalling tropical cyclone rainfall	Dr. Zifeng Yu Shanghai Typhoon Institute, CMA
3. Typhoon Quantitative Precipitation analysis and forecasts based on the Radar data analysis Prof. Dong In Lee	Meteorological Radar specialist Pukyung National University, Busan, Korea
4. Role of midlatitude baroclinic condition in heavy rainfall events induced by tropical cyclones over the Asia	Dr. Chail Park Seoul National University, Seoul, Korea
5. Application of Short-range Warning of Intense Rainstorms in Localized System (swirls) with Vietnam radar data and high-resolution NWP to improve quantitive precipitation forecast (QPF) of tropical cyclone landfalled Vietnam's coastal	Dr. Hoang Phuc Lam Viet Nam Meteorological and Hydrological Administration
6. Advances in forecasting location and location uncertainty using an ensemble of ensembles (super ensemble)	Dr. Craig Earl-Spurr Bureau of Meteorology, Australia
7. Recent advances in the understanding of tropical cyclone motion	Prof. Kosuke Ito Kyoto University, Japan
8. Future of Forecasts: IbFW for Tropical Cyclone	Dr. Senaka Basnayake Director, Climate Resilience Department, Asian Disaster Preparedness Center
9. Coastal hazards and their risk analysis	Mr. Nadao Kohno Meteorological Research Institute/JMA, Japan

Figure 1: Roving Seminar 2023: Advances in Tropical Cyclone Monitoring and Prediction for Impact Based Forecasting (28 – 30 June 2023, Hanoi, Vietnam)

3.6 The seminar was attended by 39 participants from China (6); Hong Kong, China (3); Macao, China (2); Republic of Korea (4); Thailand (4) and Viet Nam (20). Nine resource persons came from China (1); Japan (2); Republic of Korea (2), Thailand (1), Viet Nam (2) and Australia (1) and two representatives came from the Typhoon Committee Secretariat (TCS). The participants considered that the lectures and advice provided by the speakers are useful. They also gained knowledge on tropical cyclone monitoring and prediction. Participants also indicated that some hand-on training will be useful and expertise on implementing research outcomes into operational practices (research to operations) can be considered in the future. A summary report of the seminar can be found in Annex III.

Forecasters' Training Attachment

3.7 The RSMC Tokyo successfully hosted its Attachment Training course on operational tropical cyclone forecasting from 15 to 26 January 2024. Seven forecasters from Hong Kong, China, Lao PDR, Macao, China, Malaysia, the Philippines, Republic of Korea and Vietnam in the Typhoon Committee as well as two forecasters from Saudi Arabia and Sri Lanka in the Panel on Tropical Cyclone attended the training. In this training, not only

researchers but also Japanese experts from the Typhoon Committee's Hydro and Disaster Risk Reduction group and the weathercaster were invited as lecturers, with the expectation that the training would give forecasters a broader perspective and contribute to the UN's EW4ALL initiative.

Figure 2: RSMC Tokyo Attachment Training in 2024 (15-26 January 2024, Tokyo, Japan)

3.8 CMA's Typhoon Forecaster Training Programme, namely the 2023 International Training Course on Tropical Cyclone Monitoring and Forecasting Operation and Advanced Management, has been successfully conducted at the Guangdong-Hong Kong-Macao sub-center of the World Meteorological Center Beijing, Guangzhou, China on 20 November – 1 December 2023. A total of 35 participants from over 30 countries and regions joined the training workshop, including 6 trainees from TC. A variety of topics from tropical cyclone motion and structure, analysis and nowcast, use of satellite remote sensing techniques and experience sharing among participants and invited experts, and disaster management were delivered. The training workshop and programme design were well appreciated by the participants, most of them reflected that the training materials are highly useful and practical for operational applications.

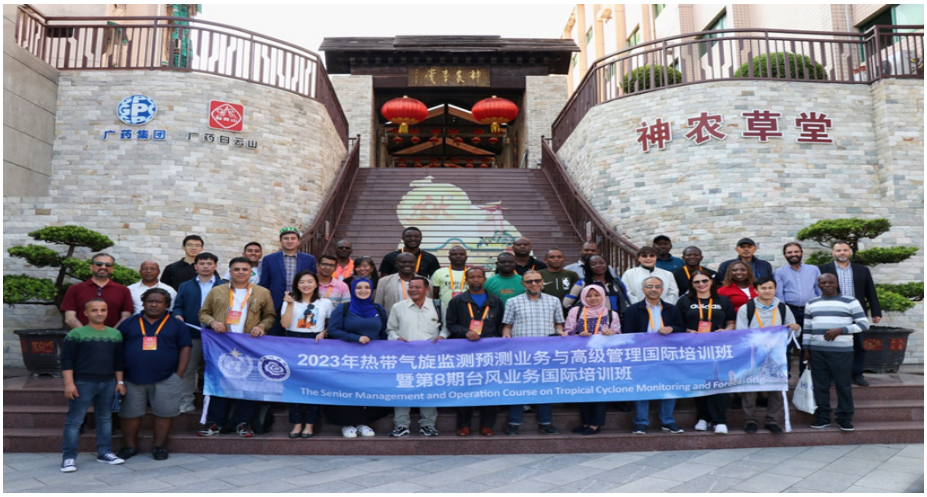


Figure 3. CMA's Typhoon Forecaster Training Programme (20 November – 1 December 2023, Guangzhou, China)

Research Fellowship Scheme

3.9 The Research Fellowships are awarded to Members to promote joint research through the exchange of visiting scientists on a short-term basis with voluntary funding and logistic support by host Members. One of the merits of the scheme is that the visiting fellow has a chance to work closely with forecasters, experienced scientists or forecast system developers at the host centre, providing an opportunity to transfer knowledge and latest research findings to operational applications. The scheme has worked well on the basis of bilateral cooperation mutually agreed between the host and the applicant.

3.10 With the alleviation of COVID-19, Hong Kong, China offered a fellowship research project in Q1 2024 on the topic entitled "A study on analogue forecasting for track and intensity of tropical cyclones using deep-learning techniques". A research fellow from Thai Meteorological Department joined the fellowship programme. He carried out the literature review on traditional and deep-learning based on methods on analogue forecasting for tropical cyclone or related extreme weather events.

3.11 NTC/KMA offered the fellowship in 2023 with research topics including "Characteristics Analysis of Binary TC Interaction" and "Analysis of the Mechanism for Rapid Intensification". Mr. Jun Ezra M. Bulquerin from the Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA), and Mr. Somprat Srithagon from the Thailand Meteorological Department (TMD) participated in the fellowship from June 11th to June 24th, 2023. The participants conducted an analysis on the typhoon case of Binary TC interaction and TC RI using GK2A and KIM data.

3.12 For future research fellowship arrangement, opportunities in coordination with AP-TCRC under time-bound pilot projects or related on-going research initiatives would also be explored. Information of the latest projects under the scheme, as well as a summary of previous fellowships awarded, can be found in Annex IV. Publications and papers published in connection with the scheme are listed in Annex V.

Asia-Pacific Typhoon Collaborative Research Centre (AP-TCRC)

3.13 The 54th Session of TC (TC54) endorsed the theme of the time-bound pilot project, namely, "Advances in application of new observations and technologies for improving tropical cyclone prediction in various time scales and related disaster prevention activities". Three research topics have been considered that AP-TCRC has planned to commence a first phase of attachment around / after mid-2023, preferably in-person visits, subject to COVID-19 situation by that time. A couple of online discussion meetings were conducted by the Chair and Vice Chair of TRCG with Dr TANG Jie and Dr FANG Zheqing of STI / AP-TCRC to formulate the attachment programme and related logistical arrangement. Updates on the development of attachment programme were presented at the 17th IWS. Draft documents of the attachment visits including the application / nomination procedures and selection criteria, etc., would be available from AP-TCRC for seeking comments from TRCG and other WGs, and for reporting at TC55 about the progress. Discussions on Time-bound Pilot Project between AP-TCRC and TRCG were conducted. The research topic "Understanding of rapid intensification mechanism of tropical cyclone and influence of climate change" was included in the "Priority Funding Missions for 2023" of the *International Tropical Cyclone Collaborative Research Guide (2023-2025)*. Under this project, Prof. Porpattama Hammachukiattikul of Thailand visited AP-TCRC and engaged in this project. Three research teams have been established, each comprising internationally-acclaimed meteorologists: Typhoon Scientific Experiments, Digital Typhoon Technology, and Typhoon Disaster Prevention Strategies, along with a comprehensive management office team. These three teams together with several research institutions, carried out the field experiment on the impact of typhoons on coastal megacities for the first time in China. On the basis of the experiment, the typhoon modeling and digital application for coastal megacities were explored. Other studies on typhoon climate have also been conducted, and results have been published in several international journals.

4. Resource Support for Research and Training

4.1 The available resource persons on specialized research subjects provided by Members are tabulated for reference in Annex VI.

4.2 The Pacific International Training Desk (PITD) (website: http://pacificdesk.org), funded by the USA's National Weather Service as part of the US contribution to the WMO Voluntary Cooperation Program (VCP) is currently managed by the Telecommunications and Social Informatics (TASI) Research Program at the University of Hawaii.

4.3 Up until 2016, all the PITD training were conducted at the RSMC Honolulu. In 2016, the PITD training reached out to include the Weather Service Offices in Micronesia. The training continued in a virtual capacity in 2022 due to the ongoing global pandemic. There are two levels of training offered: Basic (I) and Intermediate (II). The introductory training itself consists of four components: (a) basic forecaster training, to be implemented through use of e-learning modules that will be readily available to anyone;

(b) a month long, instructor led onsite training program carried out at RSMC Honolulu and/or WFO Guam; (c) training on use of communications equipment, also to be funded by the VCP: and (d) in-Island workshops on severe weather event topics.

4.4 An intermediate course was started in 2018 and is offered as a supplemental, more in-depth course for returning students. The open webinars allow students from the Micronesia Weather Service Offices and from other Pacific Islands national meteorological services to continue their development in the field of Meteorology, Hydrology and Disaster Preparedness. It also offers an insight into other Pacific Islands national meteorological services and their operations. The PITD welcomed 28 participants from six countries in five cohorts for 2023. Weather forecasters and observers from Fiji, Papua New Guinea, Samoa, Solomon Islands, Tuvalu, and Vanuatu took part in training at the Honolulu Forecast Office on the campus of the University of Hawaii (UH)-Manoa. The PITD curriculum includes introductory and intermediate weather analysis and forecasting topics, as well as communications systems training. The PITD piloted a hybrid training format this year in addition to the standard in-person training. The PITD programs include partners such as NOAA National Weather Service-Pacific Region, City and County of Honolulu Emergency Management, Joint Typhoon Warning Center, UH School of Ocean and Earth Science and Technology, and KHON2. The PITD also hosted 2 webinars on special topics such as space weather and tsunami detection technologies.

5. Prioritization of Training and Research Areas

5.1 Based on the discussion during the 4th TRCG Meeting held in conjunction with the 18th Integrated Workshop (IWS) in Bangkok, Thailand on 28 November – 1 December 2023. The priority and needs for training and research activities have been reviewed by TRCG Members and updated as follows:

(6) ***Meteorology***

Monitoring

(i) application of new technologies, especial artificial intelligence in TC analysis;
(ii) application of IoT in observation network;
(iii) application of Dvorak and microwave satellite image analysis techniques;
(iv) application of radar-based analysis/products for landfalling tropical cyclones and monsoon depressions; and
(v) application of new observation technologies (such as aircraft reconnaissance, weather buoys, automatic weather network and mobile observations) in tropical cyclone monitoring and forecasting;

Forecasting and warning

(i) application of new technologies, especially artificial intelligence, in TC track and intensity forecasting;
(ii) development and enhancement of tropical cyclone analysis and forecast techniques from nowcast to medium range, and seasonal to long-range

predictions;

(iii) development of tropical cyclone structure and intensity forecasting techniques such as rapid intensification and wind structure;

(iv) application of ensembles of guidance from global and regional dynamical models, ensemble prediction systems, conceptual models, statistical models and systematic knowledge-based approach;

(v) use of high-resolution numerical models with advanced data assimilation techniques;

(vi) rainfall forecasting: development of nowcasting and very short range forecasting techniques, and understanding of interaction between tropical cyclones and monsoon;

(vii) development of probability forecasting and extended outlook;

(viii) development of impact-based forecast and risk-based warnings; and

(ix) better understanding of wave, storm surge and marine forecasting;

(B) Meteorology and Hydrology

(i) application of new technologies, especially artificial intelligence, for forecasting of river flooding and urban flash flood;

(ii) application of meteorological and hydrological information for forecasting of river flooding and urban flash flood; and

(iii) geological hazards associated with heavy rain and tropical cyclones such as flash flood, mudslides and landslides;

(C) Meteorology and DRR

(i) development of technical procedures to quantify forecast uncertainties and to convert probabilistic information into effective warnings;

(ii) development of decision-making tools for DRR purpose, including the integration of forecast information with GIS and the use of automated information processing systems;

(iii) making use of new communication technology; and

(iv) community response and outreach effort for mitigation of the societal impact caused by disasters.

(D) Other Cross Cutting Topics

(i) better understanding of tropical cyclone related issues, such as rapid intensification, and impacts across different spatial and time scales, from mesoscale and synoptic analysis arising from El Nino/La Nina and global warming / climate change;

(ii) forecasting and warning systems for better coastal protection from multi-hazards such as storm surge, high winds, heavy rain, river delta inundation and urban flooding;

(iii) effective communication of warning messages to stakeholders, DRR users and

communities at risk; and

(iv) utilization of Big Data, social media, crowdsourcing and artificial intelligence in tropical cyclone and weather monitoring, impact assessment, DRR and public education.

6. Future Directions and Strategies

6.1 Review of the TRCG AOP 2023 can be found in Annex VII.

6.2 The 4th TRCG Meeting was successfully held on 28 November and 1 December 2023 during the 18th Integrated Workshop (IWS) in Bangkok, Thailand. The meeting note of the TRCG Meeting is in Annex VIII. New plans for TRCG in the next 4-year period from 2024 to 2027/28 has been formulated in the TRCG Meeting. The provisional TRCG work plan for 2024 to 2027/28 and Annual Operating Plan of 2024 are in Annex IX and X respectively. Research projects and training opportunities arising from the time-bound Pilot Project under the collaboration of the Committee with the Asia-Pacific Typhoon Collaborative Research Centre (AP-TCRC) have been incorporated in the TRCG's work plan and Annual Operating Plan. The 2nd online meeting of International Science Steering Committee (ISSC) was held on 26 January. Prof. Johnny C.L. CHAN reported who is the Science Director of AP-TCRC reported the (1) 2023 Progresses; (2) International Tropical Cyclone Collaborative Research Guide (2023-2025); and (3) AP-TCRC Work Plan for 2024 and ISSC members discussed the 2024 work plan. The AP-TCRC plans the international tropical cyclone scientific experiment and data analysis, Tropical Cyclone modeling, and Disaster defending techniques in 2024. The provisional TRCG and AP-TCRC work plan for 2024 to 2025 and Annual Operating Plan of 2024 are in Annex IX and X respectively.

6.3 In accordance with the 2nd TRCG meeting held on 5 December 2013, the 12 Members regularly attending the Roving Seminar are divided into three sub-regions: (1) China; DPR Korea; Hong Kong, China; Macao, China and Republic of Korea; (2) Cambodia; Philippines and Viet Nam; and (3) Lao PDR; Malaysia; Singapore and Thailand; and the seminars will normally be organized by rotation in the three sub-regions. Priority of TCTF support will be given to on-site participants from Members within the same sub-region (other than the host Member). This will help to minimize long travels and will provide more opportunities for local forecasters to attend.

6.4 U.S.A. expressed interest in hosting the roving seminar in the future during the TRCG Planning Meeting. After discussion among TRCG members, it is proposed to keep the current mechanism and add U.S.A. to Sub-Group (2). Consider the higher travel cost the TCTF budget will be adjusted for the year when U.S.A. hosts of the roving seminar to cater similar number of keynote lecturers and participants.

6.5 The initial theme of the roving seminar in the coming three years were also discussed during the TRCG planning meeting. They are (1) Application of Artificial Intelligence/Machine Learning (AM/ML) in Tropical Cyclone forecasting and Warning; (2) Application of remote sensing technologies in operational tropical cyclone monitoring

and forecasting and (3) Tropical cyclone related hazards (Storm Surge/flooding/landslides) and the application of big data/social media in weather warning services/emergency management. Thailand expressed interests to host the roving seminar in 2024.

6.6 TRCG will continue to support plans to have more cross-cutting training and research initiatives in consultation with the meteorology, hydrology and DRR components. Members are in turn encouraged to promote such initiatives through proactive involvement of the appropriate meteorological, hydrological and DRR personnel in their countries/places.

6.7 The current arrangements in RSMC Forecasters' Training Attachment operated smoothly in the past few years and will generally be maintained. Starting from 2019, the self-funded participation by Members will be considered. For better allocation of manpower, the RSMC Attachment Training will continue to be conducted during the first quarter of the year. The possibility of involving hydrologists and DRR experts in RSMC Attachment Training, CMA Typhoon Forecaster Training, and TC Research Fellowship Schemes could be explored by corresponding Members. Moreover, training and research opportunities will be explored in collaboration with WGM, WGH, WGDRR, AP-TCRC and WMO Training Centre in Nanjing as well as various interested Members if the opportunity arises.

6.8 It is expected that the planned TRCG activities in 2024 would resume in-person participation or hybrid mode of participation due to alleviation of COVID-19.

Annex I

Summary Report on the 4th TRCG Forum
28 – 29 November 2023, Bangkok, Thailand
Anh Tien DO (TRCG Chair)

1. The 4th TRCG Forum, organized in conjunction with the 18th Integrated Workshop, was successfully held on 28 – 29 November 2023 in Bangkok, China. The theme of the Forum was "Towards a Typhoon Resilience Society".

2. The TRCG Forum was officiated by Mr. Leong Weng Kun, Director of Macao Meteorological and Geophysical Bureau of Marco SAR and Chairperson of TC55, Dr Anh Tien Do, TRCG Chair, Mr Cyrill Honore, Director of Disaster Risk Reduction and Public Services Branch, Services Department, WMO and Ms Tiziana Bonapace, Director of Information and Communications Technology and Disaster Risk Reduction Division, ESCAP. Mr. Duan Yihong, Secretary of the Typhoon Committee, also delivered a welcome message during the opening ceremony.

3. There was a special session for UN Early Warning for All (EW4ALL) initiatives on the morning of 28 November. Invited experts from WMO and ESCAP delivered presentation on the status and progress of the EW4ALL implementation.

4. The TRCG forum consisted of three sessions based on the three topics under the main theme:

   Topic 1 – Artificial intelligence for tropical cyclones related applications
   Topic 2 – Special target observation over the western North Pacific
   Topic 3 – Impact based forecasting for tropical cyclones

5. Each session included three keynote presentations by invited speakers. Overall, there were nine keynote speakers, including experts from China, Japan, Republic of Korea and Thailand. The Forum was well attended with more than 130 participants coming from 11 out of 14 Members of the Committee.

6. After the keynote presentations, breakout group discussions and plenary discussion were arranged on the second day morning to discuss the challenges and opportunities as well as future development related to the three topics and the main theme. The detailed programmed of the 4th TRCG Forum is given in Attachment I of the report.

7. Key items/recommendations discussed during the breakout group discussions and plenary discussions are concisely summarized below:

(i) Topic 1 – Artificial intelligence for tropical cyclones related applications

- There is a critical need for enhanced collaboration among researchers, scientists, academic units, and operational forecasting units at national and global levels to elevate the quality and time scale of weather forecasts. A key aspect of this collaborative effort involves promoting data sharing among stakeholders to facilitate the development of artificial intelligence (AI) applications for weather and natural disaster forecasting. The availability of high-quality and well-labeled datasets is paramount for the successful development of AI models.

- AI presents a promising avenue for advancing weather and tropical typhoon forecasting, but there is room for improvement in terms of its predictive intensity. Recognizing that uncertainties in input data can impact forecast outcomes, it becomes imperative to address these uncertainties, especially in the context of climate change. Exploring the application of AI for predicting extreme weather events is crucial in this regard.

- To effectively support the Early Warning for All (EW4all) initiatives, AI should be integrated comprehensively across all processes and pillars. These include disaster risk knowledge, detection, observations, monitoring, analysis, and forecasting of hazards, as well as warning dissemination, communication, and preparedness to respond. In this holistic approach, the involvement of social scientists in the development of AI models becomes essential to account for the socio-cultural dimensions influencing disaster preparedness and response.

- While AI is a promising technique, it is essential to acknowledge its limitations. AI cannot replace human capabilities, particularly in the current stage of its development. The expertise of human forecasters and practitioners in numerical weather prediction (NWP) remains crucial. Therefore, there is a simultaneous need to promote the development of both AI and NWP to ensure a balanced and effective approach.

- In conclusion, fostering collaboration and data sharing among stakeholders is essential for improving the quality and timeliness of weather forecasts. AI holds great promise, but its potential can be fully realized only with high-quality datasets and a nuanced understanding of its limitations. Integrating AI into the

EW4all initiatives and engaging social scientists in its development will contribute to a more robust and comprehensive forecasting system. However, recognizing the ongoing importance of human expertise is crucial, necessitating the simultaneous advancement of both AI and forecasting models such as NWP.

(ii) Topic 2 – Special target observation over the western North Pacific

- To implement sharing of tropical cyclone observation data from different satellites (Himawari-9, FY-4 and GK2A), a homogeneous observation period/intensive observation period has to be defined. Suitable data adjustment (e.g. applying to the RGB method with same color pattern) is also necessary.

- Sharing of radar data may be useful to verify satellite observations, but the amount of raw data and data sharing policy have to be considered.

- Reconnaissance aircraft operations are expensive. As more tropical cyclones are moving into high latitudes due to climate change, collaborations between Members (China, Japan and Korea) to conduct reconnaissance flights over the East China Sea are encouraged.

- Other in-situ observations such as data from drifting buoys may be shared.

- For easy access and sharing of satellite data among TC Members, TCS may conduct a feasibility study to create/host a portal site which serves as a one-stop shop. However, the hosting of the site will require careful consideration of the bandwidth of satellites (for example, FY-4, Himawari-9, GK2A etc), method of sharing, and data sharing policies between Members.

- An expert term may be set up to discuss the setup of portal site, standard of measurement, collaborations between Members for in-situ observations (reconnaissance aircrafts and drifting buoys), as well as sharing of local-scale observations such as LIDAR and RADAR data.

(iii) Topic 3 – Impact based forecasting for tropical cyclones

- The impact database, such as the economic loss or damage data, is not standardized and this may hinder the development of impact-based forecast.

- The interpretation of the probabilistic forecast to the general public remains a challenge. For the communication aspect of the impact-based forecast, it would be good to involve social scientists.

- Objective verification of the impact-based forecast remains a challenge.

- There could be more cross cutting projects among different working groups of the Typhoon Committee, for example, sharing of good practices (or even not so good examples) of the development of impact-based forecast among members are strongly recommended.

- The development of impact base forecast should also take in account the impact of climate change.

8. Feedbacks and recommendations collated from the participants are summarized in Attachment II. Generally speaking, the responses from the participants are positive and they considered the event was successful. The keynote presentations and breakout discussion were useful for them to understand the latest development of the sub-topics. Most participants are very satisfied with logistics arrangement.

Figure 4: Group photos of the participants of the 18th Integrated Workshop/4th TRCG Forum on 28 November – 1 December 2023 in Bangkok, Thailand

Figure 5: Special Session for EW4ALL on the morning of 28 November 2023

Figure 6: Breakout Group Discussion of sub-topic 1 - Artificial intelligence for tropical cyclones related applications

Figure 7: Breakout group discussion of sub-topic 2 - Special target observation over the western North Pacific

Figure 8: Breakout Group Discussion of sub-topic 3 - Impact based forecasting for tropical cyclones.

Attachment I

Detailed programme of the 4th TRCG Forum

Annex IV

ESCAP/WMO TYPHOON COMMITTEE

18th Integrated Workshop/4th TRCG FORUM

"Early Warnings for All Through Enhancement of Typhoon Standard Operating Procedures (SOP)" & " Towards a Typhoon Resilient Society "

28 November – 01 December 2023

Organized by Typhoon Committee Secretariat (TCS) & Economic and Social Commission for Asia and the Pacific (ESCAP) at ESCAP Conference Center, Bangkok • Thailand

DAY 1: TUESDAY, 28 NOVEMBER 2023 – Moderated by TCS & TRCG Chair

MEETING ROOM: PLENARY CR-4

08:30-09:00 Registration

09:00-09:40 Opening Ceremony – moderated by TCS

Welcoming Remarks

TC Chair – Mr. LEONG Weng Kun, Director, *Macao Meteorological and Geophysical Bureau (SMG) of Macao SAR, TC55 Chairperson*

TRCG Chair – Dr. Anh Do, *Director General, Department of Science, Technology and International Cooperation, Vietnam Meteorological and Hydrological Administration (VNMHA)*

WMO – Mr. Cyrille Honoré, *Director of Disaster Risk Reduction and Public Services Branch, Services Department, WMO*

ESCAP – Ms. Tiziana Bonapace, *Director, Information and Communications Technology and Disaster Risk Reduction Division, ESCAP*

Welcome Message – Mr. DUAN Yihong, *Typhoon Committee Secretary, TCS*

09:40-10:00 Group photo and Coffee/Health Break

10:00-11:00 UN Early Warnings for All (EW4ALL) INITIATIVE – moderated by TCS

(20 minutes for each presentation)

1. EW4ALL - its status, progress and planned implementation - Mr. Cyrille Honoré, Director of Disaster Risk Reduction and Public Services Branch, Services Department, WMO
2. EW4ALL - Transboundary Context – Mr. Sanjay Srivastava, chief of disaster risk reduction/ IDD, ESCAP
3. WMO hydrological and water resources activities in RAII and their contributions to EW4ALL - Ms. Kim Hwirin, WMO RAII, Chief Hydrology

11:00-12:30 4TH TRCG FORUM - KEYNOTE LECTURES Session 1 (PLENARY) on the TRCG theme *"TOWARDS A TYPHOON RESILIENT SOCIETY "* – moderated by TRCG Chair

Topic 1: Artificial intelligence for tropical cyclones related applications

(25 minutes for each presentation)

1. Digital Typhoon: Datasets, Tasks and Challenges for Machine Learning Research on Tropical Cyclones – *Dr. Asanobu KITAMOTO, National Institute of Informatics (NII) / Typhoon Science and Technology Research Center, Yokohama National University, JAPAN*
2. FengWu: Data-driven Global Weather Forecasting and Its Application in Tropical Cyclone Predictions – *Dr. Lei BAI, Shanghai AI Laboratory, CHINA*
3. Development of new rainfall products by adapting AI technology to Himawari-8 - *Dr. Taichi TEBAKARI, Director, Asia Water Science Research Center, Dept. of Civil and Environmental Engineering Chuo University, JAPAN*

12:30-13:30 Lunch

13:30-15:00 4TH TRCG FORUM - KEYNOTE LECTURES Session 2 (PLENARY) – moderated by TRCG Chair

Topic 2: Special target observation over the western North Pacific

(25 minutes for each presentation)

1. Practice of rapid response of CMA FY-4B satellite observation system for typhoon monitoring – *Dr. Feng Lu, National Weather Satellite Center, CMA, CHINA*
2. Overview of KPOP-MS and field experiment plan KPOP-MS: Korea Precipitaton Observation Program - International collaborative experiments for Mesoscale convective System in Seoul metropolitan area – *Dr. Eun Jeong Cha, National Meteorological Research Institute, KMA, REP.KOREA (online)*
3. Field Experiment Study for Orographic Precipitation Observation in Korea - *Dr. Dong In Lee, Pukyong National University, REP.KOREA*

(Coffee/Health Break*)

15:00-16:30 4TH TRCG FORUM - KEYNOTE LECTURES Session 3 (PLENARY) – moderated by TRCG Chair

Topic 3: Impact based forecasting for tropical cyclones

(25 minutes for each presentation)

1. Impact-based ensemble forecasting of tropical cyclones -*Dr. Yohei SAWADA, JAPAN*
2. Impact-based Forecasting and Warning for Tropical Cyclones – *Dr. Senaka Basnayake, ADPC, THAILAND*
3. Challenges for the second half of the implementation of the Sendai Framework for Disaster Risk Reduction - *Dr. Yuichi Ono, Tohoku University, JAPAN*

16:30-17:00 Q&A

End of DAY 1

DAY 2: WEDNESDAY, 29 NOVEMBER 2023

BREAKOUT ROOMS: PLENARY CR-4; MR-H; MR-D MEETING ROOM: PLENARY CR-

08:30-11:30 4TH TRCG FORUM - TOPICAL DISCUSSION (BREAKOUT GROUPS) – moderated by TRCG Chair and Vice-TRCG Chairs

(*Breakout Discussions 3 groups*)

11:30-12:30 WRAP-UP DISCUSSION of the 4TH TRCG FORUM - (PLENARY) – moderated by TRCG Chair

Outcomes from each topic group (key scientific and technical issues)

Attachment II

Summary of the evaluation received for the 4th TRCG Forum

TRCG ACTIVITIES EVALUATION FORM

4th TRCG Forum
(Bangkok, Thailand, 28-29 November 2023)

27 responses
(not all questions answered by responders)

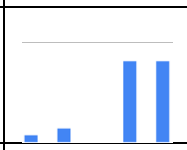
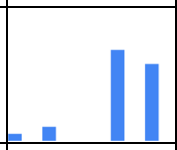
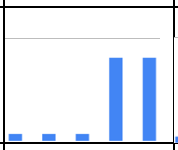
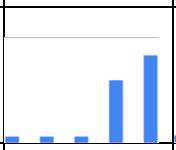
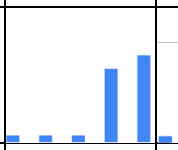
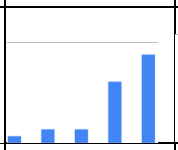
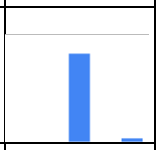
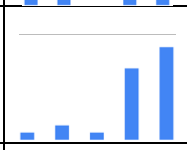
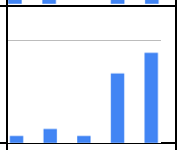
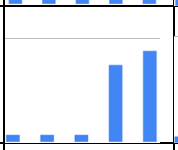
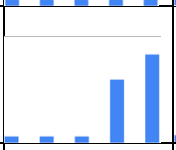
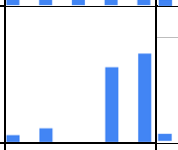
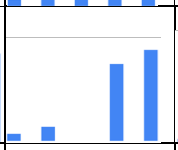
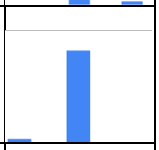
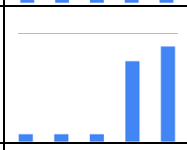
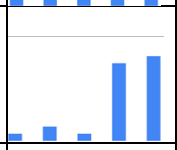
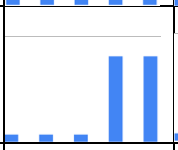
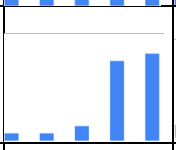
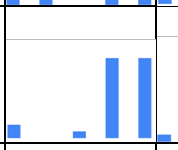
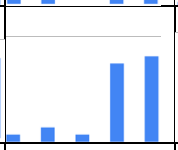
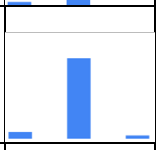
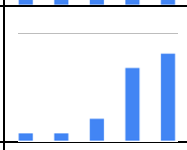
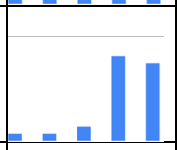
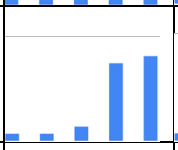
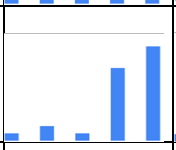
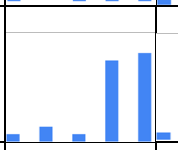
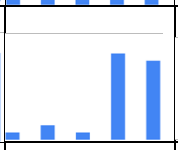
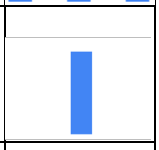
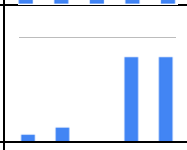
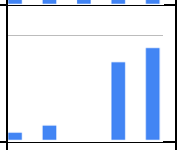
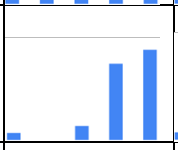
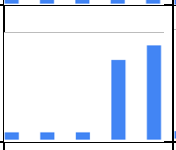
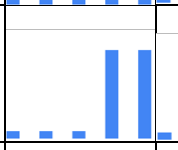
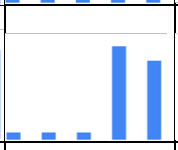
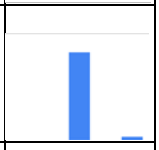
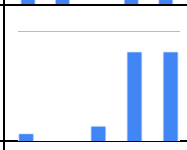
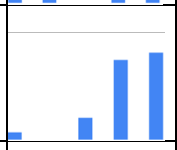
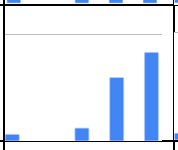
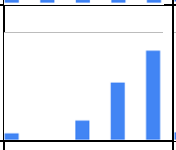
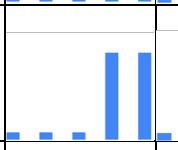
Part A: Event Logistics

Expectation levels as indicated number of responders	Below expectation☹	Met expectation😐	Exceeded expectation☺
1. Overall administration/organization	1	15	11
2. Pre-event arrangement and liaison	0	19	7
3. Venue facilities	0	14	12
4. Informative announcements and instructions	0	12	14
5. Travel arrangements	2	15	9
6. Funding arrangements	0	14	8
7. Accommodation	4	14	8
8. Refreshments	5	16	5
9. Social events and visitors' information	1	16	8
10. Helpfulness and friendliness of organizers	0	13	13

Specific points for improvement, if any:

- Need summary of Keynote speech in the end of TRCG-4
- Need more Coffee

Part B: Keynote Presentations

Keynote Presentation	Interest in Topic (1-5)	Topic Contents (1-5)	Topic Organization (1-5)	Presentation (1-5)	Language (1-5)	Effectiveness (1-5)	Technical level (L/M/R)
	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	L M R
1							
2							
3							
4							
5							
6							
7							
8							
9							

Note:

Interest in Topic: 1=disinterested, 5=most interested

Topic Contents: 1=irrelevant, 5=most relevant

Topic Organization: 1=loosely structured, 5=well-structured

Lecture/Workshop Presentation: 1=poor, 5=excellent

Language: 1=hard to understand, 5=easy to follow

Effectiveness: 1=little understanding gained, 5=much understanding gained

Technical level: L = too elementary; M = just right; R = too difficult

Part C: Follow-ups

1. What operational benefits (new ideas, skills or methodology) you think would be gained from your attendance in the event?

- Could shared recent AI technology
- New mathematics skills on AI and updates IBF knowledge
- More informed about AI
- Mainly idea related to machine learning acquired could benefit.
- The application of AI in broader areas
- Update the technology to improve TC forecasting
- New ideas on AI and IBF
- Learn more about AI Forecasting System
- Should be more than to sharing information or training with other country developed.
- Should be give information to participates
- Possible application of AI technology, knowledge of ensemble impact based forecasting, DRR techniques
- AI was really informative and gives a good glimpse of how forecast guidance, especially in the context of tropical cyclones, can be presented in the near future
- Implementation of AI model, machine-learning based TC intensity evaluation and ensemble forecast
- What needs for typhoon observation in terms of satellites
- This provided an opportunity for discussion within our organization regarding AI technology.
- Rapid scan service for typhoon monitoring
- Reinforcing the needs of the community via IBF and communications thru local and regional partnerships
- Research techniques shared by some researchers could help us to understand the characters of TCs

2. Any foreseeable opportunity for operational implementation of the above benefits?

Answer: Yes, benefits likely to be felt in about ____ year's time.
(a) a couple of years or less 3
(b) in 2 – 5 years 6
(c) in 5 years or more 6
(d) no foreseeable opportunity 3

Annex II

Summary of Roving Seminars

Year	Dates	Venue	Topic	Lecturers
2003	20 – 21 Oct	Seoul	Interpretation of Typhoon Forecasts and Analyses	Dr. H-J Kwon Mr. MANNOJI Nobutaka
	22 – 24 Oct	Hong Kong	Interpretation of Satellite Data and Use of Radar Data in Operational Tropical Cyclone Forecasting	Dr. Mark Lander Dr. P.W. Li Dr. B.-J. Sohn
	27 – 29 Oct	Shanghai	Interpretation of Satellite Data and Use of Radar Data in Operational Tropical Cyclone Forecasting	Dr. Mark Lander Dr. P.W. Li
2004	22 – 24 Nov	Beijing	Operational Application of Multi-model Ensemble Typhoon Forecasts	Prof. Johnny C.L. Chan Mr. MANNOJI Nobutaka
	25 – 27 Nov	Kuala Lumpur	Operational Application of Multi-Model Ensemble Typhoon Forecasts	Prof. Johnny C.L. Chan Mr. MANNOJI Nobutaka
2006	4 – 7 Sep	Ha Noi	Tropical Cyclone Motion and Intensity, and Principles of Dvorak Method	Prof. Johnny C.L. Chan Mr. Joe Courtney Dr. B.-J. Kim
2007	5 – 8 Sep	Manila	Satellite and Radar Analysis Techniques, and Tropical Cyclone Interaction with Monsoon Systems	Mr. Roger Edson Mr. Bart Hagemeyer Dr. NAKAZAWA Tetsuo
2009	16 – 19 Nov	Nanjing	Forecasting of High-impact Weather associated with Tropical Cyclones, and Formulation and Communication of Warning Messages	Mr. S.T. Chan Mr. Chip Guard Mr. Sam Muchemi
2010	30 Nov – 3 Dec	Ubon Ratchathani	Tropical Cyclone Genesis and Large Scale Interaction	Mr. S.M. Lee Prof. Zhang Qinghong Dr. Mark Lander
2011	20 – 23 Sep	Petaling Jaya	Heavy Rain and Flood Hazards associated with Landfalling Tropical Cyclones	Dr. Siriluk Chumchean Mr. H.Y. Yeung Prof. Chen Charng-Ning
2012	30 Oct – 1 Nov	Seoul	Tropical Cyclone Damage Assessment and Impact Forecast	DRR experts from NDMI Ms. Xu Jing Mr. W.K. Wong

2014	3-5 Nov	Hong Kong	Warning communication	Mr. Chip Guard Mr. Ahmed Nadeem Ms. Sandy, M.K. Song Mr. K.L. Lee
2015	4-6 Nov	Lao PDR	Flash flood and landslides	Mr NAGAI Yoshiki Prof. Xu-dong Fu Dr. Dong-ryul Lee
2016	15-17 Nov	Viet Nam	Storm Surge	Mr. KOHNO Nadao Mr. Author Taylor Mr. Dickson Lau
2018	20-22 Nov	Singapore	Application of Remote Sensing Technologies	Mr. YAMASHITA Koji Dr. Xiang Fang Mr. Ray Kong
2019	11-13 Nov	China	Quantitative precipitation estimation and forecasting (QPE/QPF)	Mr. W C Woo Mr. Erik Beaker Prof. NAKAKITA Eiichi
2023	28-30 Jun	Viet Nam	Advances in Tropical Cyclone Monitoring and Prediction for Impact based fo recasting	Assoc. Prof. Dr. Pham Thi Thanh N ga Dr. Zifeng Yu Prof. Dong In Lee Dr. Chail Park Dr. Hoang Phuc Lam Dr. Craig Earl-Spurr Prof. Kosuke Ito Dr. Senaka Basnayake Mr. Nadao Kohno

Annex III

Report of Roving Seminar

SUMMARY OF TYPHOON COMMITTEE ROVING SEMINAR 2023
(Hanoi, Viet Nam, 28-30 June 2023)

I. Organization

1. The Typhoon Committee Roving Seminar (TCRS) 2023 with the theme "Advances in Tropical Cyclone Monitoring and Prediction for Impact-based Forecasting" was successfully held in hybrid mode on 28-30 June 2023 in Hanoi, Viet Nam. It was organized by ESCAP/WMO Typhoon Committee (TC) and hosted by the Viet Nam Meteorological and Hydrological Administration (VNMHA).

2. The Seminar was attended by 39 participants from China (6); Hong Kong, China (3); Macao, China (2); Republic of Korea (4); Thailand (4) and Viet Nam (20). Nine resource persons came from China (1); Japan (2); Republic of Korea (2), Thailand (1), Viet Nam (2) and Australia (1) and two representatives came from the Typhoon Committee Secretariat (TCS). The list of participants is given in Attachment A.

II. Opening

1. The TCRS 2023 was officiated by Dr. Hoang Duc Cuong, Vice Administrator of VNMHA. Dr. Hoang delivered the opening speech, welcoming the participants and lecturers attending the Seminar in person and online. He hoped that the Roving Seminar could give a bridge to the scientists, researchers and forecasters to share and strengthen the hydro-meteorological forecasts and contribute to the prevention and mitigation of natural disasters, economic development in each Member in the context of global climate change.

2. The Secretary of TCS, Dr. Duan Yihong in his address expressed his gratitude to Viet Nam for hosting the Roving Seminar as it was one of the main activities of the TC, coordinated by the TRCG since 2003. He also expressed his gratitude to the speakers from various countries for sharing valuable experiences in tropical cyclone monitoring and prediction which help Members to have a better understanding of the topic and improve their forecasts to provide a more effective disaster risk reduction approach.

III. Seminar Programme

1. There were 3 days in the Seminar Programme. On Day 1, there were three lectures. Assoc. Prof. Dr. Pham Thi Thanh Nga from Viet Nam Institute of Meteorology, Hydrology and Climate Change delivered a lecture on "TC-induced rainfall forecasting in Vietnam by using GFS selective ensemble with GSMaP".

2. Dr. Zifeng Yu from Shanghai Typhoon Institute, CMA delivered a lecture on "Current estimation, understanding and forecast of landfalling tropical cyclone rainfall".

3. Prof. Dong In Lee from Pukyung National University delivered a lecture on "Typhoon quantitative precipitation analysis and forecasts based on the radar data analysis".

4. On Day 2, there were four lectures. Dr. Chail Park from Seoul National University delivered a lecture on "Role of mid-latitude baroclinic condition in heavy rainfall events induced by tropical cyclones over Asia".

5. Dr. Hoang Phuc Lam from VNMHA delivered a lecture on "Application of short-range warning of intense rainstorms in localized system (SWIRLS) with Vietnam radar data and high resolution NWP to improve quantitative precipitation forecast (QPF) of tropical cyclone landfilled Vietnam's costal".

6. Dr. Craig Earl-Spurr from Bureau of Meteorology delivered a lecture on "Advances in forecasting location and location uncertainty using an ensemble of ensembles (super ensemble).

7. Prof. Kosuke Ito from Kyoto University delivered an online lecture on "Recent advances in the understanding of tropical cyclone motion".

8. On Day 3, there were two lectures. Dr. Senaka Basnayake from Asian Disaster Preparedness Center delivered a lecture on "Future of Forecasts: IbFW for tropical cyclone".

9. Mr. Nadao Kohno from Meteorological Research Institute, JMA delivered a lecture on "Coastal hazards and their risk analysis".

10. Technical visits to Ninh Binh Province Hydro-Meteorological Center and Red River Delta Regional Hydro-Meteorological Center were conducted in the afternoon of 30 June 2023.

11. The Roving Seminar Programme is given in Attachment B.

IV. Proposals and Recommendations

1. The participants gave a warm appreciation to the nine resource persons for their presentations and useful advice as well as examples of good practices on the relevant topics.

2. During the wrap up discussion, most participants indicated that they gained knowledge on tropical cyclone monitoring and prediction. The feedbacks and recommendations collated from the participants are summarized in Attachment C.

3. Suggestions from the resource persons and organizers for future reference:
   (a) Some hands-on training will be useful;
   (b) The levels of the lectures can be adjusted according to the level of the participants, if the latter can be known in advance;
   (c) Expertise on implementing research outcomes into operational practices (research to operations) can be considered in future activities.

V. Closing

1. The resource persons and participants expressed their gratitude to the VNMHA for hosting this seminar and for the warm hospitality.

2. Dr. Do Tien Anh, the Chairperson of TRCG, and Mr. Clarence Fong, the Meteorologist of TCS presented the attendance certificates to the participants.

3. The Roving Seminar was closed on 30 June 2023.

Attachment A

List of Participants of the Typhoon Committee Roving Seminar 2023
(Hanoi, Viet Nam, 28-30 June 2023)

Members	Name of Participants
China	Mr Liu Longsheng Dr Yan Ruikai (online) Mrs Zeng Jinyu (online) Ms Guo Chunya Ms Lu Weiping Dr Jiang Xianling
Hong Kong, China	Mr Leung Ka Fai (online) Mr Wong Ka Hing (online) Dr Chow Wang (online)
Macao, China	Mr Wong Man Chi (online) Mr Pun Chi Hang (online)
Republic of Korea	Ms Lee Jung-Rim (online) Mr Shin Kyeong Chan (online) Ms Won Seonghee (online) Ms Hyoun YooSun (online)
Thailand	Mr Chanupong Photchanakrai Mr Gowich Sa-ard (online) Mr Pariwat Namduang (online) Mr Suphakrit Khotwiang (online)
Viet Nam	Mr. Hoang Phu Cuong Dr. Du Duc Tien Mr. Mai Khanh Hung Mr. Nguyen Van Huong Dr. Pham Thi Thanh Hoa Dr. Ngo Thi Thanh Huong Ms. Bui Thi Khanh Hoa Ms. Nguyen Thanh Thuy Ms. Dang Thi Anh Ms. Vu Thi Ngoc Lan Ms. Lai Thanh Ha Ms. Vu Thi Hong Giang Mr. Dao Anh Cong Mr. Nguyen Viet Anh Mr. Nguyen Mau Nghia Ms. Pham Thi Phuong Mr. Tran Van Nhuong Mr. Vu Van Dung

	Mr. Nguyen Van Huan Ms. Le Thi Bich Ngoc

Resource persons	Dr. Zifeng Yu Prof. Dong In Lee Dr. Hoang Phuc Lam Prof. Kosuke Ito (online) Dr. Craig Earl-Spurr Assoc.Prof.Dr. Pham Thi Thanh Nga Mr. Nadao Kohno Dr. Senaka Basnayake Dr. Chail Park
TCS	Dr. Duan Yihong Mr. Clarence Fong

Attachment B

Typhoon Committee Roving Seminar 2023
Seminar Programme

Dates and Venue: 28-30 Jun 2023, Headquarters of Viet Nam Meteorological and Hydrological Administration (VNMHA), Ha Noi, Viet Nam

Theme: Advances in Tropical Cyclone Monitoring and Prediction for Impact-based Forecasting

Time	**Content**	
Day 1, Wednesday, June 28, 2023 | In-person: 12th Floor - Room 1201 | Virtual: ID Zoom: 941 3282 6838 - Password: kttv@2023		
08:30-09:00	Registration	Organizing Committee
09:00-10:00	Introduction	Organizing Committee
	Welcome Remarks	***Dr. Hoang Duc Cuong*** Vice Administrator, VNMHA
	Welcome Remarks	***Dr. Duan Yihong*** Typhoon Committee Secretary
	Opening Remarks	***Dr. Do Tien Anh*** Chairman of TRCG, Typhoon Committee
	Group photo	Organizing Committee / All participants
10:00-10:30	Break	
10:30-10:45	Report and experience sharing by the participants	Viet Nam
10:45-11:00	Report and experience sharing by the participants	Thailand
11:00-12:00	TC-induced Rainfall forecasting in Vietnam by using GFS selective ensemble with GSMaP	***Assoc. Prof. Dr. Pham Thi Thanh Nga*** Viet Nam Institute of Meteorology, Hydrology & Climate Change
12:00-13:30	Lunch	
13:30-15:00	Current estimation, understanding, and forecast of landfalling tropical cyclone rainfall	***Dr. Zifeng Yu*** Shanghai Typhoon Institute, CMA
15:00-15:30	Break	
15:30-17:00	Typhoon Quantitative Precipitation analysis and forecasts based on the	***Prof. Dong In Lee*** Meteorological Radar specialist

	Radar data analysis	Pukyung National University, Busan, Korea.
17:30	Reception - 14th Floor	All participants
Day 2, Thursday, June 29, 2023 | In-person: 2nd Floor - Room Tran Van An | Virtual: ID Zoom: 941 3282 6838 - Password: kttv@2023		
09:00-09:15	Report on sharing experiences of the participants	China
09:15-09:30	Report on sharing experiences of the participants	Korea (Virtual)
09:30-10:30	Role of midlatitude baroclinic condition in heavy rainfall events induced by tropical cyclones over the Asia	***Dr. Chail Park*** Seoul National University, Seoul, Korea
10:30-10:50	Break	
10:50-11:50	Application of Short-range Warning of Intense Rainstorms in Localized System (swirls) with Vietnam radar data and high resolution NWP to improve quantitive precipitation forecast (QPF) of tropical cyclone landfalled Vietnam's coastal	***Dr. Hoang Phuc Lam*** Viet Nam Meteorological and Hydrological Administration
11:50-13:30	Lunch	
13:30-15:00	Advances in forecasting location and location uncertainty using an ensemble of ensembles (super ensemble).	***Dr. Craig Earl-Spurr*** Bureau of Meteorology, Australia
15:00-15:30	Break	
15:30-17:00	Recent advances in the understanding of tropical cyclone motion	***Prof. Kosuke Ito*** (Virtual) Kyoto University, Japan
Day 3, Friday, June 30, 2023 | In-person: 2nd Floor - Room Tran Van An | Virtual: ID Zoom: 941 3282 6838 - Password: kttv@2023		
09:00-10:00	Future of Forecasts: IbFW for Tropical Cyclone	***Dr. Senaka Basnayake*** Director, Climate Resilience Department, Asian Disaster Preparedness Center
10:00-10:15	Break	
10:15-11:30	Coastal hazards and their risk analysis	***Mr. Nadao Kohno*** Meteorological Research Institute/JMA, Japan
11:30-12:00	Summary and Closing	***Dr. Do Tien Anh*** Chairman of TRCG, Typhoon Committee

12:00-13:00	Lunch	
13:00-18:00	Visit Ninh Binh Province Hydro-Meteorological Center, Red River Delta Regional Hydro-Meteorological Center	All participants

Attachment C

TRCG ACTIVITIES EVALUATION FORM
Roving Seminar 2023
(Ha Noi, Viet Nam, 28-30 Jun 2023)

16 responses (out of 10 participants + 6 lecturers)
(not all questions answered by responders)

Part A: Event Logistics

Expectation levels as indicated number of responders (*P = participants; R = resource persons*)	Below expectation		Met Expectation		Exceeded expectation		no response	
	P	R	P	R	P	R	P	R
1. Overall administration/organization	0	0	0	3	9	3	0	0
2. Pre-event arrangement and liaison	0	0	2	3	7	3	0	0
3. Venue facilities	0	0	2	2	7	3	0	1
4. Information announcements and instructions	0	0	3	2	6	4	0	0
5. Travel arrangements	0	0	1	4	6	1	2	1
6. Funding arrangements	0	0	2	3	5	2	2	1
7. Accommodation	0	0	1	2	7	3	1	1
8. Refreshments	0	1	1	3	7	2	1	0
9. Social events and visitors' information	0	0	1	3	7	2	1	1
10. Helpfulness and friendliness of organizers	0	0	1	0	7	6	1	0

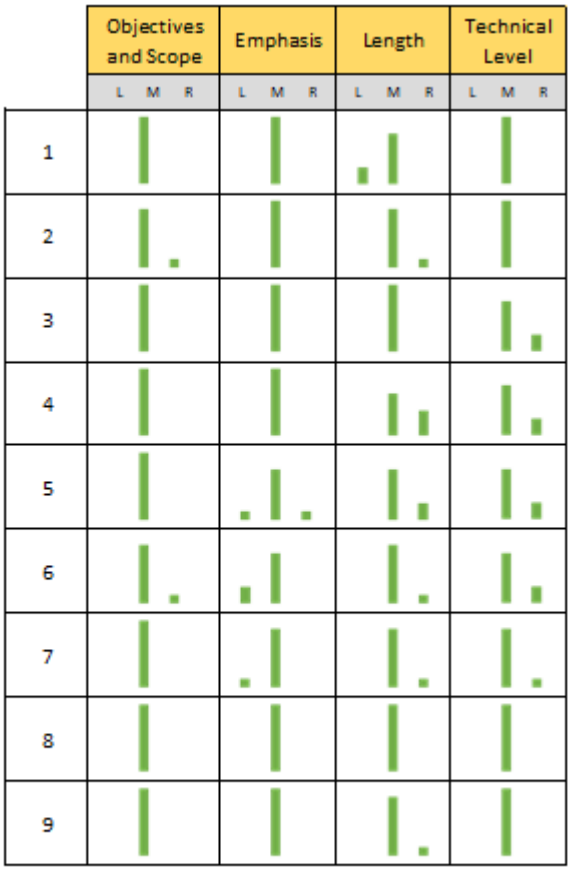
Specific points for improvement, if any:

The seminar room's condition was not good.
Improvement of the cooling system/Need cold water to drink.
Need laser point and demo computer.
Suggest to change the seminar holding season. (not in hot summer)
Earlier arrangement and guidance for seminars. (visa problem)

Part B: Technical Contents (from participants only)

Lecture	Interest in Topic (1-5)	Topic Contents (1-5)	Topic Organization (1-5)	Lecture/ Workshop Presentation	Training or Practical Material(1-5)	Language (1-5)	Effectiveness (1-5)
	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
1							
2							
3							
4							
5							
6							
7							
8							
9							

Interest in Topic:	1=disinterested, 5=most interested
Topic Contents:	1=irrelevant, 5=most relevant
Topic Organization:	1=loosely structured, 5=well structured
Lecture/Workshop Presentation:	1=poor, 5=excellent
Training or Practical Material:	1=ill-prepared, 5=well-prepared
Language:	1=hard to understand, 5=east to follow
Effectiveness:	1=little understanding gained, 5=much understanding gained



* Objectives and Scope
L = too narrow
M = just right
R = too wide

* Emphasis
L = too theoretical
M = just right
R = too practical

* Length
L = too short
M = just right
R = too long

* Technical Level
L = too elementary
M = just right
R = too difficult

Lectures:

1. Application of Short-range Warning of Intense Rainstorms in Localized System (swirls) with Vietnam radar data and high resolution NWP to improve quantitive precipitation forecast (QPF) of tropical cyclone landfalled Vietnam's coastal by Mr. Hoang Phuc Lam/Du Duc Tien
2. Current estimation, understanding, and forecast of landfalling tropical cyclone rainfall by Dr. Zifeng Yu
3. Typhoon Quantitative Precipitation analysis and forecasts based on the Radar data analysis by Prof. Dong In Lee
4. Role of midlatitude baroclinic condition in heavy rainfall events induced by tropical cyclones over the Asia by Dr. Chail Park
5. TC-induced Rainfall forecasting in Vietnam by using GFS selective ensemble with GSMaP by Dr. Pham Thi Thanh Nga
6. Advances in forecasting location and location uncertainty using an ensemble of ensembles (super ensemble) by Dr. Craig Earl-Spurr
7. Recent advances in the understanding of tropical cyclone motion by Prof. Kosuke Ito
8. Future of Forecasts: IbFW for Tropical Cyclone by Dr. Senaka Basnayake
9. Coastal hazards and their risk analysis by Mr. Nadao Kohno

Part C: Follow-ups

3. What operational benefits (new ideas, skills or methodology) you think would be gained from your experience in the event?

- New ideas, change in needs and demand
- Knowledge about Tropical Cyclone and heavy rainfall forecasting
- Ensemble products to forecast the TC
- Predicting and monitoring typhoon paths using radar images and profilers
- Get information about the term IbFW (Impact-based Forecasting and Warning)

4. Any foreseeable opportunity for operational implementation of the above benefits?

☐ No foreseeable opportunity

☐ Yes, benefits likely to be felt in about _____ years' time.

(a) a couple of years or less 2
(b) in 2-5 years 1
(c) in 5-7 years 1
(d) in 10 years or more 3
(e) no foreseeable opportunity

Figure 9: The participants of the Roving Seminar taking a group photo with the Vice

Administrator of Viet Nam Meteorological and Hydrological Administration, Dr. Hoang Duc Cuong (9th to the right in first row), the Chairperson of TRCG, Dr. Do Tien Anh (8th to the right in first row) and the Secretary of TCS, Dr. Duan Yihong (10th to the right in first row) and the lecturers.

Annex IV

Summary of Awarded Research Fellowships

Subject	Fellow	Host	Period
Analysis of evolution of landfalling tropical cyclones with a view to developing forecast guidance for wind and rain	Mr. XUE, Jianjun (China)	Hong Kong Observatory	1 Feb – 31 Mar. 2001
TC track forecasting with use of super-ensemble	Dr. PENG, Taoyong (China)	Korea Meteorological Administration	15 Jun – 15 Nov 2001
Near real-time analysis of the wind structure of tropical cyclones	Dr. Nathaniel T. SERVANDO (Philippines)	Hong Kong Observatory	5 May – 4 Jul 2002
Numerical modelling on typhoon intensity change	Ms. YU, Hui (China)	Kongju National University and Korea Meteorological Administration	15 Jul –15 Sep 2002
Tropical cyclone track forecasting method	Dr. KANG, Bom Jin Dr. KIM, Tae Jin (DPR Korea)	Shanghai Typhoon Institute	Feb – Mar 2001 Oct – Nov 2002
Analyses on the responses of extratropical transition of tropical cyclone to its environment	Dr. Vicente B. MALANO (Philippines)	Korea Meteorological Administration	Jun – Aug 2004
Effect of tropical cyclone bogussing on model analysis and forecasts	Ms. WANG, Dongliang (China)	Hong Kong Observatory	11 Oct – 10 Dec 2004
Evaluation of the model performance in typhoon prediction in the high-resolution global model (T426L40)	Ms. Sugunyanee YAVINCHAN (Thailand)	Kongju National University and Korea Meteorological Administration	1 Aug – 30 Oct 2005
Impact study of Moisture Data on TC forecasting in South China Sea and Western North Pacific	Dr. Vicente B. MALANO (Philippines)	Hong Kong Observatory	20 Sep – 19 Nov 2005
Using ensemble prediction system (EPS) information in tropical cyclone forecasting	Ms. CHEN, Peiyan (China)	Hong Kong Observatory	13 Oct – 12 Dec 2006
Numerical simulation of Typhoon RUSA with a very high resolution mesoscale	Mr. HOA, Vo Van (Viet Nam)	Korea Meteorological Administration	Jun – Aug 2006

model, and calibration of intensity of typhoon with Kalman filtering			
Use of EPS information in TC forecasting	Mr. NGUYEN, Dang Quang (Viet Nam)	Hong Kong Observatory	15 Sep – 14 Nov 2007
Seasonality of Tropical Cyclone Activities over the Western North Pacific	Ms. YING, Ming	Korea Meteorological Administration	22 Sep – 20 Dec 2008
Study of high resolution non-hydrostatic model in prediction of landfalling tropical cyclones	Mr. Santi SUMDIN (Thailand)	Hong Kong Observatory	20 Oct – 19 Dec 2008
Tropical cyclone bogus in NHM and its impact on forecast track and intensity	Mr. QU, Anxiang (China)	Hong Kong Observatory	29 Oct – 28 Dec 2009
Typhoon Vortex Initialization Scheme and typhoon Ensemble Forecast Techniques	Ms. NGUYEN Thi Minh Phuong (Viet Nam) and Mr. Chatchai CHAIYASAEN (Thailand)	National Meteorological Center, China Meteorological Administration	Early Dec 2009 – Early Feb 2010
Improvement of typhoon analysis and forecast with KMA's TAPS	Mr. TRAN Quang Nang (Viet Nam)	Korea Meteorological Administration	1 Sep – 27 Nov 2010
Study on the tropical cyclone genesis in the northwestern Pacific	Mr. Kamol Promasakha Na SAKOLNAKHON (Thailand)	Korea Meteorological Administration	1 Sep – 27 Nov 2010
Typhoon Information Processing System	Mr. NGUYEN Manh Linh (Viet Nam) and Ms. Kamolrat SARINGKARNPHASIT (Thailand)	National Meteorological Center, China Meteorological Administration	8 Oct – 8 Dec 2010
Can the extreme rainfall associated with Typhoon Morakot (0908) happen in Hong Kong?	Mr. HUANG, Yiwu (China)	Hong Kong Observatory	29 Oct – 28 Dec 2010
Improvement of typhoon analysis and forecast with KMA's TAPS	Mr. Jori J. LOIZ (Philippines)	Korea Meteorological Administration	Sep – Nov 2011
Improvement of typhoon analysis and forecast with KMA's TAPS	Mr. Chukiat THAIJARATSATIAN (Thailand)	Korea Meteorological Administration	Sep 2011
Implementation of Tropical Cyclone Intensity Forecast in the Tropical Cyclone Information Processing System (TIPS) of the Hong Kong Observatory	Mr. Nursalleh K. CHANG (Malaysia)	Hong Kong Observatory	24 Oct – 23 Dec 2011

Improvement of Prediction Method for the Rapid Intensification of Tropical Cyclones in the South China Sea	Dr. Sukrit KIRTSAENG (Thailand)	National Meteorological Center, China Meteorological Administration	2 Nov – 29 Dec 2011
Application of Numerical Ensemble Prediction in the Forecasting of Typhoon Sharp Turning Tracks	Mr. Raymond C. ORDINARIO (Philippines)	National Meteorological Center, China Meteorological Administration	14Nov 2011 – 13 Jan 2012
Typhoon Analysis and Prediction System (TAPS), genesis and dissipation of tropical cyclones, and change of typhoon characteristics due to climate change	Mr. Renito B. PACIENTE (Philippines), Ms. Plaidao KHUMCHAIYAPHUM (Thailand) and Mr. Bounteum SYSOUPHANTHAVONG (Lao PDR)	Korea Meteorological Administration	May – June 2012
Enhancement of rainfall nowcast in tropical cyclone situation	Mr. Maqrun Fadzli Mohd Fahmi (Malaysia) and Mr. Michael S. Bala (Philippines)	Hong Kong Observatory	22 Oct – 21 Dec 2012
Optimizing typhoon forecast using Typhoon Analysis and Prediction System (TAPS), and research on intensity and track forecasts using model ensemble, correction of track forecast bias according to synoptic patterns, and analysis of synoptic features and typhoon model forecast errors in anomalous typhoon tracks.	Dr. Bonifacio Galt Pajulelas (Philippine) , Mr. Nguyen Huu Thanh (Vietnam), and Ms. Prapaporn Wongsaming (Thailand)	Korea Meteorological Administration	1 May – 30 June 2013
Development of location-specific severe weather nowcasting techniques.	Dr. Sukrit KIRTSAENG (Thailand)	Hong Kong Observatory	21 Oct – 20 Dec 2013
Optimizing typhoon forecast using Typhoon Analysis and Prediction System (TAPS) and separate researches (typhoon-mid latitude pressure system interaction, study on the typhoon recurvature and moving speed, and study on the relationship between the central pressure and maximum sustained winds for typhoon)	Ms. Bai Lina (China) Mr. Nguyen Tung Thanh (Vietnam) Mr. Juanito S. Galang (The Philippines)	Korea Meteorological Administration	1 May – 30 June 2014

Tropical Cyclone Genesis Forecast Technique	Mr. Boonthum Tanglumlead (Thailand)	Shanghai Typhoon Institute	1 Jul – 31 Aug 2014
The utilization of ECMWF products in detecting storm tracks over the North Western Pacific	Mr. Pak Sang Il and Mr Song Yong Chol (DPR Korea)	Shanghai Typhoon Institute	1-30 Sept 2014
Nationwide Nowcast of Tropical Cyclone Rainfall	Mr. Evan James K. Carlos (The Philippines)	Hong Kong Observatory	6 Oct – 5 Dec 2014
Optimizing typhoon forecast using Typhoon Analysis and Prediction System (TAPS), and research on typhoon monitoring, interpretation of satellite-based and radar images, typhoon track and intensity forecast and tropical depression or extra-tropical transition	Ms. Akhom THAMALANGSY (Lao PDR) Mr. Aldczar D. Aurelio (The Philippines), Mr. Jose Frivaldo, JR. (The Philippines), Mr. Somprat Srithagon (Thailand), and Ms. DO Thi Thanh Thuy (Viet Nam)	Korea Meteorological Administration	19 April - 2 May 2015
Tropical cyclone genesis forecast technique	Mr. Pak Sang Il (DPR Korea) Mr. Ri Hak Il (DPR Korea)	Shanghai Typhoon Institute	26 Oct - 25 Nov 2015
Visiting editor for Tropical Cyclone Research and Review (TCRR)	Dr. Jason Sippel (USA) Dr. Nguyen Dang Quang (Viet Nam)	Shanghai Typhoon Institute	6-13 Dec 2015 20-26 Dec 2015
Development of objective guidance on tropical cyclone genesis forecast using global models	Mr. Wen FENG (China)	Hong Kong Observatory	Mid Nov 2015 – mid Jan 2016
Training for typhoon forecast - Typhoon genesis and analysis - Typhoon track and intensity forecast - TAPS* operations and products	Benison Jay N. Estareja(The Philippines) Boonthum Tanglumlead(Thailand) Narongpon Thongsang(Thailand)	Korea Meteorological Administration	1 May to 14 May 2016
Tropical cyclone genesis forecast technique	Mr. Pak Sang Il and Mr. Kim Kum Song (DPR Korea)	Shanghai Typhoon Institute	24 October to 23 November 2016
Visiting editor for Tropical Cyclone Research and Review (TCRR)	Mr. Kamol Promasakha na Sakolnakhon (Thailand) Dr. Chen Yi-Leng (USA)	Shanghai Typhoon Institute	17-21 October 2016

Tropical Cyclone Size Climatology	Mr. Wei HONG (China)	Hong Kong Observatory	mid-Dec 2016 – 31 Jan 2017
Training for typhoon forecast - Typhoon genesis and analysis - Typhoon track and intensity forecast - TAPS* operations and products	Ms. Pensiri Trisataya and Ms. Chuanpit Ngernchalad (Thailand) Mr. Robert B. Badrina (The Philippines) Ms. Hoang Thi Mai (Viet Nam)	Korea Meteorological Administration	16-29 April 2017
Observational Study on Intensity and Structure of Offshore Typhoon for EXOTICCA	Mr. Jaral Yiemwech (Thailand) Ms. Khanh Hoa Bui Thi (Viet Nam)	Shanghai Typhoon Institute	September 2017
Benefit evaluation of Typhoon disaster prevention and preparedness	Mr. Nursalleh Chang (Malaysia)	Shanghai Typhoon Institute	September 2017
Visiting Editor for Tropical Cyclone Research and Review	Mr. Somkuan Tonjan (Thailand) Dr. Doan Quang Tri from (Viet Nam)	Shanghai Typhoon Institute	February 2018
Tropical Cyclone Precipitation Verification	No nomination was received	Shanghai Typhoon Institute	NA
Short-term Rainfall Forecast for Tropical Cyclone Using Himawari-8 Data and NWP Model Products	Applicant who was accepted for the fellowship withdrew from the offer	Hong Kong Observatory	NA
Benefit evaluation of Typhoon disaster prevention and preparedness	Mr. Nursalleh K Chang (Malaysia)	Shanghai Typhoon Institute	2 May – 1 June 2018
Training for forecasters: - Tropical meteorology & climatology - Processing observed meteorological variables - Typhoon analysis and monitoring- - Producing typhoon information using TAPS and TOS - Seasonal typhoon prediction	Mr. Nuthakit Singhaphet, (Thailand) Mr. Tran Quang Nang, Typhoon (Viet Nam) Dr. Guanbo Zhou (China) Mr. Robb Prieto Gile (the Philippines) Mr. Wan Muhammad Hafiz Bin Husin, (Malaysia)	Korea Meteorological Administration	23 April to 4 May 2018
Short-term Rainfall Forecast for Tropical Cyclone Using Himawari-8 Data and NWP Model Products	Ms. Nguyen Thu Hang (Viet Nam)	Hong Kong Observatory	January – March 2019

Training for forecasters: - Tropical meteorology & climatology - Processing observed meteorological variables - Typhoon analysis and monitoring- - Producing typhoon information using TAPS and TOS - Seasonal typhoon prediction	Ms. Reyes Sheilla Mae R. (the Philippines) Mr. Tran Van Vu (Viet Nam)	Korea Meteorological Administration	20 May to 14 June 2019
Visiting Editor for Tropical Cyclone Research and Review	Prof. Kimberly Wood (USA) Prof. Shishir Dube (India)	Shanghai Typhoon Institute	24-29 March 2019 13-19 October 2019
Integrated Precipitation Estimator using Radar and Satellite (IPERS) for Tropical Cyclone Rainfall (TC) Analysis and Nowcasting	Mr. Benison Jay N Estareja (the Philippines)	Hong Kong Observatory	January – February 2020
Verification of tropical cyclone wind structure forecasts from global NWP models and ensemble prediction system	Ms Xiaoqin LU (China)	Hong Kong Observatory	Q1 2021
Study on the characteristics and model forecast performance of rapid intensification (RI) of near-landfall tropical cyclones (TCs)	Mr Nawin Sermsook (Thailand)	Hong Kong Observatory	Q1 2022
Study on the characteristics and model forecast performance of rapid intensification (RI) of near-landfall tropical cyclones (TCs)	Ms Xiang Chunyi (China)	Hong Kong Observatory	Q1 2023
Characteristics Analysis of Binary TC Interaction Analysis of the Mechanism for Rapid Intensification	Mr. Jun Ezra M. Bulquerin (Philippines) Mr. Somprat Srithagon (Thailand)	Korea Meteorological Administration	11-24 June 2023
Study on analogue forecasting for track and intensity of tropical cyclones using deep learning techniques	Mr. Boonyuen Pakornpop (Thailand)	Hong Kong Observatory	Q1 2024

TRCG Publications / Papers

Xue, J.J., 2002: Structural and Diagnostic Analyses of Landfalling Tropical Cyclones near Hong Kong in 1999 and 2000. Typhoon Committee Annual Review 2001, pp. 153-161

Servando, N.T., P.W. Li and E.S.T. Lai, 2003: Near Real-time Analysis of the Wind Structure of Tropical Cyclones. Typhoon Committee Annual Review 2002 (in CD form)

Peng, T.-Y., H.-J. Kwon, W.-J. Lee, and J.-H. Lim, 2005: A systematic approach to tropical cyclone track. *The International Journal of Systems & Cybernetics.* **34**, 681-693.

Wang, D.L., W.K. Wong and E.S.T. Lai, 2005: A Study on Tropical Cyclone Bogussing Strategies in NWP Model Analysis and Forecast. Typhoon Committee Annual Review 2004.

Yu, Hui and H. Joe Kwon, 2005: Effect of TC–Trough Interaction on the Intensity Change of Two Typhoons. *Weather and Forecasting.* **20**, 199–211.

Malano, V.B., W.K. Wong and E.S.T. Lai 2006: Effect of Moisture Data to the Numerical Simulation of Tropical Cyclone in the Western North Pacific. Typhoon Committee Annual Review 2005, pp. 242 – 251.

Chen, P.Y. and S.T. Chan, 2009: Use of the JMA Ensemble Prediction System for Tropical Cyclone Intensity Forecasting. Typhoon Committee Annual Review 2008, pp. 276-285.

Nguyen, D.Q. and S.T. Chan, 2009: Study on Application of Ensemble Prediction System Information in Tropical Cyclone Track Forecasting. Typhoon Committee Annual Review 2008, pp. 286-291.

Wong W.K., S. Sumdin, and E.S.T Lai 2010: Development of Air-Sea Bulk Transfer Coefficients and Roughness Lengths in JMA Non-hydrostatic Model and Application in Prediction of an Intense Tropical Cyclone. Scientific Online Letters on the Atmosphere (SOLA), **6**,

65-68.

Chan, S.T. and Y. Huang, 2012: Can the Extreme Rainfall Associated with Typhoon Morakot (2009) Happen in Hong Kong? Tropical Cyclone Research and Review, **1**, 1-15.

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Annex VI

List of Resource Persons

Member	Specialties	Name	E-mail	Affiliation
(A) Data Assimilation				
China	TC vortex initialization	LIANG, Xudong	Liangxd@mail.typhoon.gov.cn	Shanghai Typhoon Institute
	TC intensity estimation by radar, satellite, SSMI and QuikScat	DONG, Lin ZHOU, Bing	donglin@cma.gov.cn bingz@cma.gov.cn	National Meteorological Center
	Radar data quality control and assimilation scheme	GONG, Jiandong	gongjd@cma.gov.cn	National Meteorological Center
Hong Kong, China	TC data assimilation, ensemble radar assimilation	K. K. HON	kkhon@hko.gov.hk	Hong Kong Observatory
Japan	Satellite data assimilation	OKAMOTO Kozo	kokamoto@mri-jma.go.jp	Meteorological Research Institute
	Data assimilation	ISHIBASHI Toshiyuki	ishibasi@mri-jma.go.jp	Meteorological Research Institute

(A) Data Assimilation (cont'd)				
Republic of Korea	Typhoon bogussing	HA, Ji-Hyun	jhha80@korea.kr	Korea Meteorological Administration
	Satellite data analysis	CHUN, Hyoung-Wook	chunhw@korea.kr	Korea Meteorological Administration
	Radar data analysis	HA, Jong-Chul	bellfe@korea.kr	Korea Meteorological Administration
USA (western North Pacific)	TC analysis, satellite interpretation, use of microwave imagery and scatterometer data	Tom LEE Peter BLACK Paul CHANG	Lee@nrlmry.navy.mil Peter.Black.ctr@nrlmry.navy.mil Paul.S.Chang@noaa.gov	NRL, Monterey, CA NRL, Monterey CA NOAA/NESDIS, Suitland MD
Viet Nam	TC vortex initialization; Typhoon bogussing	NGUYEN, Van Hiep	hiepwork@gmail.com	Viet Nam Meteorological and Hydrological Administration
(B) Modelling				
China	Numerical schemes of TC model	DUAN, Yihong	duanyh@mail.typhoon.gov.cn	Shanghai Typhoon Institute
	TC model physics and bogussing schemes	MA, Suhong	mash@cma.gov.cn	National Meteorological Center
	Ensemble track forecasting	ZHOU, Xiaqiong	zhouxq@mail.typhoon.gov.cn	Shanghai Typhoon Institute
	Typhoon modelling	LIANG, Xudong	Liangxd@mail.typhoon.gov.cn	Shanghai Typhoon Institute
Hong Kong, China	Mesoscale and ensemble TC	K.K. HON	kkhon@hko.gov.hk	Hong Kong Observatory

	modelling			

(B) Modelling (cont'd)				
Japan	Ensemble track forecasting	KAWABATA Yasuhiro	kawabata@mri-jma.go.jp	Meteorological Research Institute
	TC-ocean interaction (incl. mixed-layer ocean and ocean surface wave modelling)	WADA Akiyoshi	awada@mri-jma.go.jp	Meteorological Research Institute
	TC modeling	TSUJINO Satoki	satoki@mri-jma.go.jp	Meteorological Research Institute
	Storm surge / wave modelling	KOHNO Nadao	nkohno@mri-jma.go.jp	Meteorological Research Institute
Republic of Korea	Global NWP model	CHOI, Hyun-Joo	hjchoi81@korea.kr	Korea Meteorological Administration
	Ensemble track forecasting	SHIN, Hyun Cheol	sinhyo@korea.kr	Korea Meteorological Administration
	Storm surge / wave modelling	CHANG, Pil-Hun	phchang@korea.kr	Korea Meteorological Administration
USA (western North Pacific)	TC Modeling Extratropical Transition TC Genesis Sub-Tropical Systems Structure	Jim DOYLE Pat HARR Jenni EVANS	James.Doyle@nrlmry.navy.mil paharr@nps.edu evans@meteo.psu.edu	NRL, Monterey CA Naval Postgraduate School, Monterey CA Pennsylvania State Univ

(C) Forecasting				
China	Track and intensity forecasting	QIAN, Qifeng	qianqf@cma.gov.cn	National Meteorological Center
	Long-range prediction of typhoon	XU, Ming	Xum@mail.typhoon.gov.cn	Shanghai Typhoon Institute
Hong Kong, China	TC climatology and best track analysis	C.W. CHOY	cwchoy@hko.gov.hk	Hong Kong Observatory
	Radar and satellite nowcasting in TC	W.K. WONG	wkwong@hko.gov.hk	Hong Kong Observatory
	TC intensity, structure and landfall impact	S.T. CHAN	stchan@hko.gov.hk	Hong Kong Observatory
	Long-range forecasting of TCs	S.M. LEE	smlee@hko.gov.hk	Hong Kong Observatory
	TC motion, intensity, size, modelling and seasonal prediction	Johnny C.L. CHAN	Johnny.Chan@cityu.edu.hk	City University of Hong Kong.
Japan	Satellite data analysis, use of microwave imagery, AMSU	OYAMA Ryo	oyama@met.kishou.go.jp	Japan Meteorological Agency
	Doppler radar data analysis	SHIMADA Udai	ushimada@mri-jma.go.jp	Meteorological Research Institute
Republic of	Track and intensity forecasting	LEE, Kyung-Ho	khlove1119@korea.kr	Korea Meteorological Administration

Korea	Long-range prediction of typhoon			
Singapore	Seasonal prediction of typhoon	CHOW Kwok Wah	CHOW_Kwok_Wah@nea.gov.sg	Meteorological Service Singapore National Environment Agency
(C) Forecasting (cont'd)				
USA (western North Pacific) USA (western North Pacific)	TC analysis and forecasting, seasonal prediction, use of microwave imagery and scatterometer data, Dvorak technique	Roger EDSON	Roger.Edson@noaa.gov	University of Guam (WERI) National Weather Service, Forecast Office Guam
	Satellite data analysis, use of microwave imagery	Jorel TORRES Dan LINDSEY	Jorel.Torres@colostate.edu Dan.Lindsey@colostate.edu	NOAA/NESDIS at CIRA, Colorado State University
	Satellite data analysis, use of microwave	Chris VELDEN Derrick HERNDON	chris.velden@ssec.wisc.edu dherndon@ssec.wisc.edu	CIMSS, University of Wisconsin-Madison

	imagery, automated Dvorak Technique, AMSU			
	Satellite data analysis, use of microwave imagery, AMSU	John KNAFF	john.knaff@noaa.gov	NOAA/NESDIS at CIRA, Colorado State University
	Satellite-based rainfall estimates in TCs (eTRaP)	Bob KULIGOWSKI Shelden KUSSELSON	bob.kuligowski@noaa.gov sheldon.kusselson@noaa.gov	NOAA/NESDIS Suitland, Maryland
Viet Nam	Track and intensity forecasting; Typhoon-terrain interaction and application in forecasting; TC related heavy rainfall and strong wind forecast.	NGUYEN, Van Hiep	hiepwork@gmail.com	Viet Nam Meteorological and Hydrological Administration
(D) Application				
Hong Kong,	TC warning systems and operations	H.Y. YEUNG	hyyeung@hko.gov.hk	Hong Kong Observatory

China	TC information visualization and display systems	C.K. PAN	ckpan@hko.gov.hk	Hong Kong Observatory
USA (western North Pacific)	TC warning and disaster preparedness, seasonal prediction, Dvorak technique	Chip GUARD	chip.guard@noaa.gov	NOAA National Weather Service Guam

Annex VII

Review of Training and Research Coordination Group (TRCG) Annual Operating Plan 2023 (including Q1 of 2024)											
Objective Number	**KRA**	**Objective**	**Action**	**Other WGs Involved**	**TCS Responsibility**	**Expected Quarter Completed**	**Other Organizations Involved**	**Success Indicators**	**Funding Required**	**Funding Sources**	**Review and Target Met (Yes/No)**
1	KRA 1-3	To enhance TC Members' capacity and knowledge in operational tropical cyclone forecasting	Attachment of forecasters from TC Members to RSMC Tokyo	nil	Provision of administrative and logistic support.	Q1 (11-13 Jan 2023)	RSMC Tokyo, WMO	Assessment as given in RSMC Tokyo report.	USD 11,000*	TCTF and Member self-funded	Yes
2	KRA 1-3	To facilitate technology transfer among TC Members through research and development initiatives	Research Fellowship	WGM, WGH and WGDRR	Provision of administrative and logistic support.	Q1 of 2023	TC Members	Publication of research findings and development output in TCRR or other journals	Fellowship offered by voluntary hosts.	TC Members	Yes (Conducted Online)
3	KRA1-3	To enhance TC Members' capacity and knowledge in operational tropical cyclone forecasting	Up to 4 forecasters from TC to CMA Forecaster Training	nil	Provision of administrative and logistic support.	Q3-Q4 (24 Oct – 4 Nov 2022)	CMA	Assessment as given in CMA report.	Participation will be supported by CMA	CMA	Yes
4	KRA 1-3	To: (a) implement training initiatives in the priority operational and research areas as identified in the TRCG annual report; and (b) enhance Members' capability and capacity in the assessment of damage and pre-assessment of potential impact caused by landfalling TCs	4th TRCG Forum [Towards a typhoon resilient society] and TRCG Planning Meeting (in conjunction with the 18th IWS)	WGM, WGH and WGDRR	Provision of administrative and logistic support.	*Q4 of 2023 (28 Nov – 1 Dec 2023) (in conjunction with the 18th IWS)*	-	Feedback from evaluation forms to be completed by a target audience of about 30 people.	USD 26,000	TCTF	Yes

5	KRA 1-3	To: (a) implement training initiatives in the priority operational and research areas as identified in the TRCG annual report; and (b) enhance Members' capability and capacity in the assessment of damage and pre-assessment of potential impact caused by landfalling TCs	Roving Seminar [Impact based forecasting]	WGM, WGH and WGDRR	Provision of administrative and logistic support.	*Q2 of 2023 (28 – 30 Jun 2023)*	-	Feedback from evaluation forms to be completed by a target audience of about 30 people.	USD 16,000 (Q2 of 2023)	TCTF	YES
6	KRA 1-3	To enhance TC Members' capacity and knowledge in operational tropical cyclone forecasting	Attachment of forecasters from TC Members to RSMC Tokyo	nil	Provision of administrative and logistic support.	*Q1 of 2024 (15-26 Jan 2024)*	RSMC Tokyo, WMO	Assessment as given in RSMC Tokyo report.	USD 11,000	TCTF and Member self-funded	YES

Annex VIII

Note of the 4th TRCG Meeting

Date: 30 November 2023
Time: 2:00 – 5:00 pm
Venue: UNCC, Thailand, Bangkok

1. Dr. Anh Tien Do, Chair of TRCG thanked all present for making an effort to attend the fourth TRCG Planning meeting. He also thanked Dr. Cha, co-vice-chair of the TRCG, to attend the meeting online.

2. The meeting reviewed the AOPs of TRCG in 2023. Dr Do presented a review of Typhoon Committee Roving Seminar 2023 which was held in Viet Nam on 28 – 30 June 2030 at the headquarters of VNMHA. The seminar was attended by 39 participants 6 members of the Typhoon Committee, with 9 invited speakers from hydro-meteorological agencies and universities. The participants considered that the lectures and advice provided by the speakers are useful. They also gained knowledge on tropical cyclone monitoring and prediction.

3. Dr Ikegami from RSMC Tokyo gave an overview of the RSMC Tokyo online attachment training, which was held online between 11 – 13 January 2023. 51 participants from eight members attended the training. He also reported that RSMC Tokyo will organize a face-to-face training on 15 – 26 January 2024 and encouraged the application from the Typhoon Committee Members.

4. Dr Qian from CMA presented a short summary of the 2023 International Training Course on Tropical Cyclone Monitoring and Forecasting Operations and Advanced members. A total of 35 participants from over 30 countries and regions joined the training workshop, including 6 trainees from TC. A variety of topics from tropical cyclone motion and structure, analysis and nowcast, use of satellite remote sensing techniques and experience sharing among participants and invited experts, and disaster management were delivered. The training workshop and programme design were well appreciated by the participants, most of them reflected that the training materials are highly useful and practical for operational applications.

5. Dr. Fang from AP-TCRC gave a brief overview of the recent progress of the Asia-Pacific Typhoon Collaborative Research Center (AP-TCRC).

6. Mr Choy from HKO and Dr Cha from KMA presented a short summary of the research fellowship hosted by Hong Kong, China and Republic of Korea respectively.

7. The meeting reviewed the provisional TRCG work plan for 2024 – 2027 and

reviewed the prioritization and need for training and research. All members agreed that the current list of prioritization and need for training and research is comprehensive. It was suggested to include the application of artificial intelligence in various areas including TC monitoring, forecasting and warning and hydrology.

8. The meeting discussed the initial themes of the roving seminar in the coming 3 years. The meeting generally agreed with the following initial themes of the roving seminar:

   (1) Application of Artificial Intelligence/Machine Learning (AI/ML) in Tropical Cyclone forecasting and warning;

   (2) Application of remote sensing technologies in operational tropical cyclone monitoring and forecasting;

   (3) Tropical cyclone related hazards (Storm Surge/flooding/landslides) and the application of big data/social media in weather warning services/emergency management

9. Mr Choy also briefed the current hosting mechanism of the roving seminar – the 12 Members regularly attending the Roving Seminar are divided into three sub-regions: (1) China; DPR Korea; Hong Kong, China; Macao, China and Republic of Korea; (2) Cambodia; Philippines and Viet Nam; and (3) Lao PDR; Malaysia; Singapore and Thailand; and the seminars will normally be organized by rotation in the three sub-regions. Priority of the TCTF support will be given to on-site participants from Members within the same sub-region (other than the host Member). This will help to minimize long travels and will provide more opportunities for local forecaster to attend. Mr Lau from USA expressed the interest to host roving seminar in the future. The meeting agreed to draft some options for TRCG members to decide whether there is a need for the change of the current mechanism.

   (Post meeting note: TRCG vice-chair communicated two proposals for TRCG members' consideration after the meeting, with proposal A to keep the current mechanism and add USA in sub-group 2, and proposal B to establish a sequential list table in alphabetical order for the hosting of the roving seminar). More members opined for the proposal A. Considering the higher travel cost, the TCTF budget will be adjusted for the year for USA hosting the seminar in order to cater similar number of keynote lecturers and forecasters.)

10. The meeting also discussed the hosts of the roving seminar in the coming three years. In particular, the members in sub-region (3): Lao PDR, Malaysia, Singapore and Thailand are encouraged to host the seminar in 2024. Dr Do encouraged members to host the roving seminar and the hosting schedule of the roving

seminar can be adjusted if necessary.

(Post meeting note: Thailand kindly offers to host roving seminar in 2024.)

11. The meeting also briefly discussed how to enhance the coordination between different fellowship offered by members (CMA, KMA, HKO, AP-TCRC). While it is understood that every members has its own operational requirement and research interest, the meeting agreed that if it is possible, the fellowship offered by members can be communicated with other parties as early as possible to facilitate earlier planning.

Figure 10: Photos of TRCG members attending the 4th TRCG Planning Meeting

Annex IX

Provisional TRCG Work Plan for 2024 – 2027 (including Q1 of 2028)

Year	Quarter	Typhoon Committee Activity	Training and Research Activities (*activities organized by parties other than TRCG)	Themes (if any) / Remarks
2024	Q1	TC-56 (Malaysia)	RSMC Tokyo Attachment Training	15 – 26 January
			Research Fellowship	HKO Fellowship in Jan - Mar
	Q2		Research Fellowship	Fellowship or attachment visit(s) hosted by KMA, STI
	Q3		Roving Seminar	To be held in Thailand. Proposed theme: TBC
	Q4	19th IWS (China)	CMA Training Programme*	TBC
			1st AP-TCRC International Workshop	TBD
			AP-TCRC Fellowship or Attachment Training	TBD
2025	Q1	TC-57 (Philippines)	RSMC Tokyo Attachment Training*	TBC
			Research Fellowship	HKO Fellowship in Jan – Mar (TBC)
	Q2		Research Fellowship	Fellowship or attachment visit(s) hosted by KMA, STI and/or
	Q3			
	Q4	20th IWS (TBC)	CMA Training Programme *	TBC
			Roving Seminar	Proposed theme: TBC
			2nd AP-TCRC International Workshop	TBD
			AP-TCRC Fellowship or Attachment Training	TBD
2026	Q1	TC-58 (TBC)	RSMC Tokyo Attachment Training*	TBC
			Research Fellowship	HKO Fellowship in Jan – Mar (TBC)
	Q2		Research Fellowship	Fellowship or attachment visit(s) hosted by KMA, STI and/or AP-TCRC
	Q3			

	Q4	21st IWS (TBC)	Roving Seminar	Proposed theme: TBD
			CMA Training Programme*	TBC
2027	**Q1**	TC-59 (TBC)	RSMC Tokyo Attachment Training*	TBC
			Research Fellowship	HKO Fellowship in Jan – Mar (TBC)
	Q2		Research Fellowship	Fellowship or attachment visit(s) hosted by KMA, STI and/or AP-TCRC
	Q3			
	Q4	22nd IWS (TBC)	5th TRCG Forum / TRCG Planning Meeting (in conjunction with 22nd IWS)	Proposed theme: TBC
			CMA Training Programme*	TBC
2028	**Q1**	TC-60 (TBC)	RSMC Tokyo Attachment Training*	TBC
			Research Fellowship	HKO Fellowship in Jan – Mar (TBC)

Annex X

Training and Research Coordination Group (TRCG) Annual Operating Plan 2024 (including Q1 of 2025)										
Objective Number	**KRAs**	**Objective**	**Action**	**Other WGs Involved**	**TCS Responsibility**	**Expected Quarter Completed**	**Other Organizations Involved**	**Success Indicators**	**Funding Required**	**Funding Sources**
1	KRA 1-3	To enhance TC Members' capacity and knowledge in operational tropical cyclone forecasting	Attachment of forecasters from TC Members to RSMC Tokyo	nil	Provision of administrative and logistic support.	*Q1 of 2024 (15-26 Jan 2024)*	RSMC Tokyo, WMO	Assessment as given in RSMC Tokyo report.	USD 11,000*	TCTF and Member self-funded
2	KRA 1-3	To facilitate technology transfer among TC Members through research and development initiatives	Research Fellowship	WGM, WGH and WGDRR	Provision of administrative and logistic support.	Q1-Q3	TC Members	Publication of research findings and development output in TCRR or other journals.	Fellowship offered by voluntary hosts.	TC Members
3	KRA 1-3	To: (a) implement training initiatives in the priority operational and research areas as identified in the TRCG annual report; and (b) enhance Members' capability and capacity in the assessment of damage and pre-assessment of potential	Roving Seminar Proposed theme:	WGM, WGH and WGDRR	Provision of administrative and logistic support.	Q3 2024	TMD	Feedback from evaluation forms to be completed by a target audience of about 30 people.	USD 16,000	TCTF

		impact caused by landfalling TCs								
4	KRA 1-3	To: conduct of international scientific workshop to raise the knowledge level of TC forecasters the ESCAP/WMO Typhoon Committee.	Invite international top scientists to participate in the 1st AP-TCRC International Workshop	WGM, WGH and WGDRR	Provision of administrative and logistic support.	Q4 2024	TRCG & AP-TCRC	Assessment as given in TRCG & AP-TCRC report	TBD	AP-TCRC
5	KRA 1-3	To: implement training initiatives Regular invitation of TC prevention and mitigation personnel to conduct technical training for members of the ESCAP/WMO Typhoon Committee.	Fellowship or Attachment of researchers from TC Members to AP-TCRC, Shanghai	WGM, WGH and WGDRR	Provision of administrative and logistic support.	Q4 2024	TRCG & AP-TCRC	Assessment as given in TRCG & AP-TCRC report	TBD	AP-TCRC
6	KRA1-3	To enhance TC Members' capacity and knowledge in operational tropical cyclone forecasting	Up to 4 forecasters from TC to CMA Forecaster Training	nil	Provision of administrative and logistic support.	Q3 – Q4 2025	CMA	Assessment as given in CMA report.	Participation will be supported by CMA	CMA
7	KRA 1-3	To enhance TC Members' capacity and knowledge in operational tropical	Attachment of forecasters from TC Members to RSMC Tokyo	nil	Provision of administrative and logistic support.	*Q1 of 2025*	RSMC Tokyo, WMO	Assessment as given in RSMC Tokyo report.	USD 11,000	TCTF and Member self-funded

		cyclone forecasting.								