

**ESCAP/WMO Typhoon Committee**  
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Fifty-Second Session  
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## **SUMMARY OF MEMBERS' REPORTS 2019**

*(submitted by AWG Chair)*

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### Summary and Purpose of Document:

This document presents an overall view of the progress and issues in meteorology, hydrology and DRR aspects among TC Members with respect to tropical cyclones and related hazards in 2019

### **Action Proposed**

The Committee is invited to:

- (a) take note of the major progress and issues in meteorology, hydrology and DRR activities in support of the 21 Priorities detailed in the Typhoon Committee Strategic Plan 2017-2021; and
- (b) Review the Summary of Members' Reports 2019 in APPENDIX B with the aim of adopting a "Executive Summary" for distribution to Members' governments and other collaborating or potential sponsoring agencies for information and reference.

### **APPENDICES:**

- 1) Appendix A – DRAFT TEXT FOR INCLUSION IN THE SESSION REPORT
- 2) Appendix B – SUMMARY OF MEMBERS' REPORTS 2019

**APPENDIX A:  
DRAFT TEXT FOR INCLUSION IN THE SESSION REPORT**

**3.2 SUMMARY OF MEMBERS' REPORTS**

1. *The Committee took note of the Summary of Members' Reports 2019 highlighting the key tropical cyclone impacts on Members in 2019 and the major activities undertaken by Members under the TC Priorities and components during the year.*
2. *The Committee expressed its sincere appreciation to AWG Chair for preparing the Summary of Members' Reports and the observations made with respect to the progress of Members' activities in support of the 21 Priorities identified in the TC Strategic Plan 2017-2021.*

***Recommendations of AWG***

3. *AWG recommended the Committee to consider the key tropical cyclone impacts on Members in 2019 and review the initiatives and activities to be pursued in support of the 21 TC Priorities to mitigate future impacts.*
4. *Any other text to be included in the Session Report.*

**APPENDIX B:  
SUMMARY OF MEMBERS' REPORTS 2019**

Raymond Tanabe (AWG Chair)

*The summary is based on Members' Reports as submitted by Members of the Typhoon Committee for the 14<sup>th</sup> IWS in Guam, USA on 4-7 November 2019. The full reports may be found in the member reports section of the 14<sup>th</sup> IWS website.*

<http://www.typhooncommittee.org/14IWS/Members14IWS.html>

**1. Objectives**

The objectives of this Summary are to extract the key aspects of tropical cyclone impacts and related topical issues of regional interest in Members' countries or territories, and to consolidate the information and observations for:

- (a) the attention of Members' governments to encourage allocating the necessary resources for the purposes of operational effectiveness and readiness, disaster mitigation and risk reduction, or leveraging available resources and support for technology transfer and capacity-building through regional cooperation initiatives; and
- (b) reference by sponsoring agencies with a view to coordinating and synergizing effort in the planning of relevant projects and programmes for such purposes, as well as channeling resources and aids into identified areas of gaps or needs.

**2. Key Observations in 2019**

**2.1 Overview (courtesy RSMC Tokyo)**

In the western North Pacific and the South China Sea, 29 named tropical cyclones formed in 2019, which was above the 30-year average. Seventeen of these reached typhoon intensity, whose ratio was also above the 30-year average.

The year 2019 started with TC PABUK that formed at 06 UTC on 1 January. It was the earliest formation since 1951, when the statistical record on TC in RSMC Tokyo – Typhoon Center started. TC PABUK crossed the border of RSMCs Tokyo and New Delhi moving to the west for the first time in around 21 years

A notable feature of the season is that no named TC formed from March to mid-June but instead, 26 named TCs formed after July 1; especially, six out of them formed in November which ties with 1964 and 1991 as the largest number of formation for the month since 1951 (see Figure 1). During the months with no named TC, convective activity in the western North Pacific remained suppressed in association with post-El Niño warming in SSTs over the Indian Ocean and southwest monsoon activity was low and delayed. This environmental condition resulted in no formation of TCs. On the other hand, in November, as many as six named TCs formed under favorable atmospheric and

oceanic conditions including: above-normal sea surface temperatures (SSTs) in the tropical Pacific east of 160°E; enhanced cyclonic vorticity between westerly winds along the equator associated with an active MJO phase and equatorial waves and easterly winds in the tropical Pacific south of 20°N.

## 2.2 Summary of Member contributions supporting the 21 Priorities of the Typhoon Committee Strategic Plan 2017-2021.

	Priorities	
1	Enhance activities to develop impact-based forecast and risk-based warning.	28
2	Strengthen cross-cutting activities among working groups in the Committee.	6
3	Enhance collaborative activities with other regional/international frameworks/organizations, including TC and PTC cooperation mechanism.	26
4	Enhance the capacity to monitor and forecast typhoon activities particularly in genesis, intensity and structure change.	26
5	Develop and enhance typhoon analysis and forecast technique from short- to long-term.	16
6	Enhance and provide typhoon forecast guidance based on NWP including ensembles and weather radar related products, such as QPE/QPF.	22
7	Promote communication among typhoon operational forecast and research communities in Typhoon Committee region.	28
8	Strengthen the cooperation with WGH and WGDRR to develop impact-based forecast and risk-based warning.	4
9	Enhance, in cooperation with TRCG, training activities in accordance with Typhoon Committee forecast competency, knowledge sharing, and exchange of latest development and new techniques.	8
10	Enhance RSMC capacity to provide regional guidance including storm surge, responding to Member's needs.	5
11	Improve typhoon-related flood (including river flood, urban flood, mountainous flood, flash flood and storm surge, etc the same below) monitoring data collection, quality control, transmission, and processing.	15
12	Enhance capacity in typhoon-related flood risk management (including dam operation), integrated water resources management and flood-water utilization.	17
13	Enhance capacity in impact-based and community-based operational flood forecasting and early warning, including methodology research, hydrological modeling, and operation system development.	19
14	Enhance capacity in flood risk (hazard, inundation) information, mapping, and its application.	20
15	Enhance capacity in assessment and dealing with the impacts of climate change, urbanization, and other human activities on typhoon-related flood disaster vulnerability and water resources availability.	9
16	Enhance capacity in advanced technology (including satellite data, GIS, RS, QPE/QPF, ensemble, parallel computing) utilization in typhoon-related flood forecasting and early warning, and hydrological modeling.	16
17	Provide reliable statistics of mortality and direct disaster economic loss caused by typhoon-related disasters for monitoring the targets of the Typhoon Committee.	4
18	Enhance Members' disaster reduction techniques and management strategies.	27
19	Evaluate socio-economic benefits of disaster risk reduction for typhoon-related disasters.	16
20	Promote international cooperation of DRR implementation project.	22
21	Share experience/know-how of DRR activities including legal and policy framework, community-based DRR activities, methodology to collect disaster-related information.	23

Overall, Typhoon Committee Members reported on over 90 initiatives supporting the 21 Priorities defined in the Strategic Plan, a remarkable number.

## **2.3 Summary of Members' Reports**

### **2.3.1 Cambodia.**

In 2019 there was only one tropical cyclone to affect Cambodia. Severe Tropical Storm MATMO made landfall in Vietnam with maximum sustained winds of 50 kt on 30 October 2019. MATMO weakened slightly before crossing into northern Cambodia on 31 October and was downgraded to a tropical depression. Thankfully there was no significant heavy rain or damages reported.

El Niño conditions delayed the arrival of the southwest monsoon. Higher than normal temperatures were observed from January through September along with below normal rainfall from January through May.

Once the southwest monsoon arrived in the 3<sup>rd</sup> week of May, rainfall returned to normal for most of the country. Coastal and plateau areas saw extremely wet conditions in August and September. A severe flash flood occurred in Sihanouk (Kampong Som Province) on 8 August 2020 where 272 mm of rain was observed in a 6 hour period.

### **2.3.2 China**

From January 1 to October 17, 2019, the northwestern Pacific and the South China Sea witnessed the generation of 19 tropical cyclones. Five made landfall over the coastal areas of China, namely, Tropical Storm MUN, Tropical Storm WIPHA, Typhoon LEKIMA, Severe Tropical Storm BAILU and Typhoon MITAG.

China noted several characteristics of tropical cyclone impacts in the region for 2019. After an early start to the season, tropical cyclone genesis during the Spring and Summer was below normal, including no genesis in March through May. The average peak intensity was markedly lower than the long-term average and there were fewer landfalling tropical cyclones in China. The landfalling systems were relatively low-intensity with the notable exception of LEKIMA which made landfall in Zhejiang Province on 10 August.

LEKIMA was the 3<sup>rd</sup> strongest typhoon to make landfall in the Zhejiang Province since 1949 and the 5<sup>th</sup> strongest for mainland China overall. Many rainfall and river stage records were broken. Warning level flooding was observed for 206 rivers in 12 provinces. Impacts from LEKIMA included 71 people dead or missing, over 2 million people evacuated, and 51.53 billion yuan in direct economic losses.

China continues to support important initiatives in the Typhoon Committee region. In May 2019, the Shanghai Meteorological Service and Shanghai Typhoon Institute hosted the 12<sup>th</sup> China-Korea Joint Workshop on Tropical Cyclones. China coordinated telephone calls with Viet Nam for experts to discuss the track and intensity of Typhoon WIPHA which impacted both southern China and northern Viet Nam. After the initial telephone calls, China and Viet Nam continued to collaborate using a web-based discussion platform called Typhoon International Conference. China continues to publish the *Tropical Cyclone Research and Review* (TCRR) journal, including two special issues on the WMO International Workshop on Tropical Cyclones. Professor Kimberly Wood from Mississippi State University participated in the Typhoon Committee Fellowship for visiting editors in May 2019.

China reported on 8 initiatives supporting Typhoon Committee Priorities in 2019. Of note were application of Artificial Intelligence for tropical cyclone intensity estimation, support of WMO Information System implementation, advances in typhoon forecasting techniques, continued research on tropical cyclones, improvements in disaster response, disaster risk reduction activities, and extensive operational training opportunities.

### **2.3.3 Democratic People's Republic of Korea (DPRK).**

No report submitted.

### **2.3.4 Hong Kong, China.**

Five tropical cyclones affected Hong Kong, China from 1 January to 28 October 2019: Tropical Depression MUN in July, Tropical Storm WIPHA, Severe Tropical Storm BAILU and Tropical Storm PODUL in August, and Tropical Depression KAJIKI in September.

In Hong Kong, WIPHA necessitated the issuance of the No. 8 Gale or Storm Signal, while KAJIKI necessitated the issuance of No. 3 Strong Wind Signal. MUN, BAILU and PODUL only necessitated the issuance of No.1 Standby Signal. Although WIPHA skirted past at about 310 km of the territory, its extensive circulation and asymmetric wind structure made it the farthest tropical storm necessitating the issuance of No.8 Gale or Storm Signal in Hong Kong since 1961.

WIPHA produced the most impacts for Hong Kong, including widespread rainfall totals exceeding 250mm with some areas receiving over 350 mm. Strong winds caused a tower crane to fall along with various scaffolding around the city. Over 850 fallen trees were reported. Heavy rain, flooding, and landslides also produced damage to buildings, homes, and farmland.

HKO continues to be very active in supporting WMO programs. The Director of the Hong Kong Observatory (HKO), Mr. Shun Chi-ming, was elected a co Vice-President of the Commission for Weather, Climate, Water and Related Environmental Services and Applications of the World Meteorological Organization (WMO) at the 18th World Meteorological Congress held in Geneva, Switzerland. HKO was also designated by WMO as the Regional Specialised Meteorological Centre (RSMC) for Nowcasting and the Testbed for Doppler Light Detection and Ranging systems. Moreover, HKO continued to operate the WMO Tropical Cyclone Forecaster Website, Severe Weather Information

Centre website SWIC 2.0 website and Global Multi-hazard Alert System for Asia on behalf of WMO.

Hong Kong reported on 12 initiatives supporting Typhoon Committee Priorities in 2019. In addition to their collaborative efforts in support of WMO, other notable achievements include enhancements which allow in-flight transmission of data from the Government Flying Service reconnaissance aircraft, deployment of drifter buoys, and their ever expanding education and outreach campaign.

### **2.3.5 Japan.**

In 2019, 19 tropical cyclones (TCs) of tropical storm (TS) intensity or higher had come within 300 km of the Japanese islands as of 16 October. The country was affected by eight of these, with five making landfall.

Typhoon HAGAPIS produced the most significant impacts for Japan. Typhoon HAGAPIS moved across portions of Western Japan on 12-13 October 2019, producing record rainfall in the Tokyo and surrounding areas. Kanagawa received over 1000 mm of rainfall and 17 other locations received over 500 mm. The torrential rains caused flooding and levee breaches in many places. Seventy people died, 11 people were missing, and 52,989 houses were inundated.

Japan detailed 8 key initiatives supporting Typhoon Committee Priorities in 2019. Amongst these initiatives, the RSMC Tokyo – Typhoon Center has improved its approach to determining probability-circle radii for operational TC track forecasts resulting in a 20 percent reduction of the radii out to 5 days. The JMA Meteorological Satellite Center also developed a method to estimate surface winds around a tropical cyclone. The resulting ASWind products are available for Himawari 8/9 full-disk and target sectors. The RSMC Tokyo – Typhoon Center continues to upgrade the Numerical Typhoon Prediction website with new features and products.

Japan remains a strong supporter of the Asian Disaster Reduction Center and continues to host Visiting Scientists and Researchers from other member countries. Through April 2019 a total of 111 officials from 26 member countries have attended the Visiting Researcher program. The Government of Turkey, Government of Japan, and ADRC jointly organized the Asian Conference on Disaster Reduction which was held in Ankara, Turkey in November 2019.

### **2.3.6 Lao PDR.**

In 2019, WIPHA, PODUL and KAJIKI directly impacted Lao PDR. MUN and MATMO provided indirect impacts.

WIPHA made landfall in northern Viet Nam as a tropical storm and then weakened into a low pressure system before passing over the northern section of Lao PDR on 3-4 August 2019. More than 100 mm of rain on these two days produced landslides and flooding over central and northern provinces. PODUL made landfall over central Viet Nam and passed through central Lao PDR on 30 August 2019 before dissipating over the Indo-China region. KAJIKI formed south of Hainan Island and made landfall in central Vietnam as a weak tropical storm. KAJIKI lingered and briefly crossed into Lao PDR on 3 September 2019 before moving back over the South China Sea and dissipating. Together, PODUL and KAJIKI produced several days of heavy rain which caused widespread flooding across six provinces.

MUN passed just north of Lao PDR while MATMO passed to the south. In both cases, heavy rains and strong winds produced flooding, landslides, and wind damage to homes and agriculture.

The Department of Meteorology and Hydrology of Lao PDR collaborated extensively with International Organizations and other donors to expand their observation network and build new infrastructure. In particular, they worked with the World Bank, JICA, Mekong River Commission, and NDMI to upgrade and expand their hydro-meteorological observation networks. Support from the World Bank and China also led the construction of a new national early warning center, TV weather studio, and a new water resources center.

The ongoing partnership between NDMI and DMH to install Automatic Rainfall Warning Systems (ARWS) and Flash Flood Alert System (FFAS) continues to be successful. In 2019 the fourth of these systems were installed in the Bolikhan District and a 5<sup>th</sup> is expected in 2020.

### **2.3.7 Macao, China**

Six tropical cyclones affected Macao, China between Oct 2018 to Sep 2019, including Severe Tropical Storm YUTU, Tropical Storm MUN, Tropical Storm WIPHA, Severe Tropical Storm BAILU, Tropical Storm PODUL and Tropical Depression KAJIKI. Of these tropical cyclones, WIPHA caused the most impacts.

WIPHA came within 270 km to Macau at its closest approach on 31 July 2019. High winds and periods of heavy rain produced relatively minor damage across Macau. The most significant impact was flooding and inundation of low lying coastal areas due to a combination of the heavy rain, astronomical high tide, and storm surge. These impacts necessitated the issuance of a Tropical Cyclone Signal No. 8 and a yellow storm surge warning.

Macao successfully hosted a meeting in support of “The third assessment report on the Climate Change Impacts on Tropical Cyclones in the Typhoon Committee region

(TCAR3). This initiative was part of the AOP items for WGM in 2018 and the final report was finished in September 2019.

Macau SMG is also in the process of revising their Rainstorm Warning Signal System which will increase the number of alert levels to three. This increase will allow the public to take the necessary precautions and safety actions.

Macau SMG is expanding and improving their services by upgrading hardware systems, conducting training of staff, performing emergency exercise drill with their partners, updating their website, weather app, and social media platforms, increasing education and outreach, and installing more hydro-meteorological observation systems.

### **2.3.8 Malaysia**

There were no tropical cyclones which directly impacted Malaysia during the reporting period.

Malaysia completed the analysis for the seven global targets from 2005-2018 in support of the Sendai Framework Monitor system. The report showed an 11% decrease in the number of deaths and missing persons. The report further showed increased in the number of people impacted, economic loss, and damage to critical infrastructure and services.

Malaysia completed an excellent preparedness campaign during October, which has been recognized as Disaster Preparedness Month since 2016. The National Disaster Management Agency, together with the Ministry of Energy, Science and Technology, Environment and Climate Change has started an initiative to compile and share maps of geological and hydro-meteorological hazards through a centralized GIS platform.

### **2.3.9 Philippines.**

In 2019 only 15 tropical cyclones entered and developed inside the Philippine Area of Responsibility (PAR), 8 Tropical Depressions, 2 Tropical Storms, 2 Severe Tropical Storms and 3 Typhoon. Fortunately, only three of these tropical cyclones shown made landfall and these were TD (Amang), TD (Crising) that weakened into a Low Pressure Area (LPA) after making a landfall and Typhoon PODUL (Jenny). Luckily, there was no significant damage during the occurrence of the tropical cyclones. The lower number of landfalling and weaker systems was a welcome relief after a very busy 2018 season.

Both TD Amang and Crising produced periods of heavy showers which produced minor damage to agriculture, homes, and other infrastructure. PODUL made landfall in the central to northern section of Luzon as a Tropical Storm. Heavy rain produced moderate flooding in the affected areas and two deaths were reported.

The Philippines continue to expand the hydro-meteorological observation network, including 14 new Synoptic Stations, 7 new S-Band Doppler Radars, six X-Band Doppler Radars, 12 High-Frequency Coastal Doppler Radars, Automatic Weather Stations, and a Lightning Detection System to assist with SIGMETs at the airports.

PAGASA expanded their Tropical Cyclone Monitoring Domain which now extends from the Equator to 35N between 110E and 155E. The vastly expanded area will help to provide early notification for potential tropical cyclone threats.

Finally, PAGASA continues to conduct numerous workshops, drills, education and outreach events, and trainings both internally and with external partners.

### **2.3.10 Republic of Korea (ROK).**

The Republic of Korea has been experienced an active typhoon season this year. Seven tropical cyclones affected the Korean Peninsula from July to October. These were DANAS, FRANCISCO, LEKIMA, KROSA, LINGLING, TAPAH and MITAG. Of these 7, FRANCISCO, LINGLING and MITAG, made landfall. The 7 tropical cyclones marked the highest number to impact the Korean Peninsula since 1959. Except for LEKIMA, each of the remaining 6 caused casualties and economic losses. LINGLING and MITAG were the most damaging. According to statistics provided by the Ministry of Interior and Safety, LINGLING produced over \$137 million in damages (USD).

ROK continues to be very proactive in assisting and building capacity of other members. KMA issues the seasonal outlook for the western north Pacific based on three types of models. KMA also delivered the Typhoon Operation System (TOS) to the Macau Meteorological and Geophysical Bureau. NTC and KMA continue to sponsor the Typhoon Research Fellowship Program of the TRCG and co-hosted 12<sup>th</sup> Korea-China Tropical Cyclone Workshop. Improvements were made to the KMA Typhoon Intensity Classification and new analysis techniques are being developed to take advantage of the GEO-KOMPSAT-2A imagery.

KMA continually works to improve their forecast and warning services. Korea also expanded their flood forecasting program to reflect the increasing trend in heavy rainfall due to climate change and is strengthening flood management accordingly. One of the main projects in support of this expansion is enhancement of flood forecasting reliability with radar observed rainfall data.

NDMI through the WGDRR was very active in Typhoon Committee activities throughout 2019, including setting up additional early warning and alert systems in Vietnam and Lao PDR, supporting and hosting the 14<sup>th</sup> annual WGDRR meeting, overseeing the WGDRR session of the Typhoon Committee Forum, and active sharing of information related to DRR efforts in the region.

### **2.3.11 Singapore.**

During the Pacific Typhoon season in 2019, the tropical storms in the South China Sea and the western Pacific Ocean did not have much influence on the weather in Singapore.

Meteorological Service Singapore expanded their already comprehensive suite of weather observing systems in 2019 to support operational needs and services. Singapore, along with other Typhoon Committee Members and Indonesia, continues to strongly support the ASEANCOF and SEA RCC-Network. MSS, as host of the ASEAN

Specialised Meteorological Centre (ASMC), conducts Capability-Building Programme in Subseasonal-to-Seasonal Predictions for Southeast Asia (S2S-SEA). S2S-SEA is a multi-year series of workshops to equip the NMHSs with the knowledge and skills to deliver S2S predictions to end-users. The third workshop was conducted in July 2019.

MSS continues to work with the National Water Agency of Singapore by providing specialized forecasts to support effective national water supply management. Singapore continuously reviews and upgrades the drainage infrastructure to alleviate flooding in urban areas.

### **2.3.12 Thailand.**

Thailand experienced significant effects from 4 tropical cyclones originating over the South China Sea and the Northwest Pacific Ocean. These were a tropical depression in mid-October 2018, Tropical Storm PABUK in early January 2019, Tropical Storm WIPHA in late July to early August 2019 and Tropical Storm PODUL in late August. There were 4 tropical cyclones - TORAJI, USAGI, MUN and KAJIKI having some effects on rainfall in Thailand.

The combined impacts of PODUL and KAJIKI, as well as the severity of southwest monsoon which prevailed over the Andaman Sea 29 August through late 2019, caused widespread flash flooding and landslides in 32 out of 76 provinces throughout Thailand. 182 districts, 969 sub-districts, 7,115 villages, 5 municipalities, 11 communities, 418,549 people were affected, 3818 houses were reported partially damaged, the death toll was 34 people and 1 person was injured. (As of 18 September, 2019)

The Thai Meteorological Department (TMD) hosted the fourth meeting of the Severe Weather Forecasting Demonstration Project (SWFDP) – Regional Sub-project Management Team (RSMT) for Southeast Asia (SeA) in September 2019. TMD collaborated with WMO to conduct the National Workshop on Strengthening Multi-Hazard Early Warning Systems. TMD also hosted a Consultation Workshop as a part of the SSOP-II Project.

TMD developed an innovative display which overlays radar imagery onto FY-4AGE and Himawari-8 satellite imagery for distribution on their website. TMD applied the Precipitation Estimation from Remotely Sensed Imagery using an Artificial Neural Networks Cloud Classification System (PERSIANN-CCS) technique to estimate the rainfall from Himawari-8 satellites images. This technique improved the rainfall estimates in areas without adequate weather observations.

### **2.3.13 United States of America.**

In the Western North Pacific (130E to 180, north of the equator), a near normal total of nineteen tropical cyclones entered or formed in the WFO Guam AOR from 1 October 2018 until 15 October 2019. This is quite a bit less than the 30 that formed within the AOR during the same period from the previous year. There were four Super Typhoons (winds greater than or equal to 130 knots, 150 mph) during this period: YUTU, WUTIP, LEKIMA and HAGABIS. YUTU was the strongest, a catastrophic Category 5 (Saffir-Simpson Scale) tropical cyclone, and had a devastating effect on the infrastructure of the islands of Tinian

and Saipan in the CNMI (but with only one fatality). This typhoon was one of the strongest tropical cyclones to make a direct hit on one of the populated islands in Micronesia in the past 50 years. Another tropical cyclone of interest was Super Typhoon WUTIP (02W) which at 140 knots (160 mph) may have been the strongest tropical cyclone on record for the northern hemisphere for the month of February. After WUTIP, tropical cyclone activity waned until later in the season in August and September.

Five tropical cyclones entered into, or were generated in, the central North Pacific during the period from January 1 through October 28, 2019. These were: Hurricane ERICK, Tropical Storm FLOSSIE, Tropical Storm AKONI, Tropical Depression KIKO, and Tropical Storm EMA. ERICK brought elevated surf to east facing shores of the Hawaiian Islands, along with moisture that contributed to heavy rainfall which resulted in damaging flash flooding to Kauai on August 4th. FLOSSIE brought elevated surf to the east facing shores as well as locally heavy rainfall to portions of west Maui, and central Oahu in early August 2019.

The US continues to expand their Weather Ready Nation initiative by recruiting new WRN Ambassadors who act as message amplifiers for NWS products and services, watches, warnings, and advisories.

NWS offices in Guam and Honolulu conduct annual tropical cyclone exercises and a variety of education and outreach activities in support of tropical cyclone awareness. The Pacific International Training Desk also continues to provide basic and advanced forecaster training which includes tropical cyclones and tsunamis.

Finally, the SSOP-II Project, managed by Tom Evans, was successfully completed and the final report will be presented at TC-53.

### **2.3.14 Vietnam.**

In 2019, there were 4 tropical cyclones which impacted Viet Nam. These were MUN, WIPHA, PODUL, and KAJIKI. MUN impacted northern Viet Nam with widespread rainfall amounts between 100-150 mm. A few locations noted much higher totals in the 200-400 mm range. WIPHA also impacted northern Viet Nam with extreme rainfall and strong winds. PODUL made landfall in central Viet Nam and rapidly weakened into a tropical depression before moving over Lao PDR. PODUL produced moderate to heavy rainfall and strong winds to the region. Finally, KAJIKI brought strong winds along with heavy and extreme rainfall to central Viet Nam.

Despite widespread flash flooding and river flooding in Viet Nam in 2018, the overall damages caused by natural disasters in Viet Nam was reduced compared to the average in recent years. The Prime Minister and Chairman of Central Committee for Natural Disaster Prevention and Control was very proactive in disaster management activities.

Vietnam continues to provide leadership in the Typhoon Committee region by leading the Severe Weather Forecasting Demonstration Project for Southeast Asia (SWFDP-SeA). In addition to provide 24/7 support of SWFDP-SeA products and services, Vietnam continues to host a 2-week course to provide direct and hands-on training. As similarly reported by China, expert forecasters from Viet Nam and China actively

collaborate on tropical cyclone which are expected to make landfall near the border between China and Viet Nam. This collaboration has proven to be very successful.

Other significant projects include upgrades to the Central Data Hub, improvements in impact-based forecasting, and a new high performance computing (HPC) platform. The new HPC has allowed advances in regional NWP products.