MEMBER REPORT
Macao, China

ESCAP/WMO Typhoon Committee
12th Integrated Workshop
Jeju, Republic of Korea
30 October – 3 November 2017

CONTENTS

I. Overview of tropical cyclones which have affected/impacted Member's area since the last Committee Session

1. Meteorological Assessment

11 tropical cyclones affected Macao, China since Oct. 2016, including Tropical Storm Aere (1619), Typhoon Sarika (1621), Typhoon Haima (1622), Severe Tropical Storm Merbok (1702), Tropical Storm Roke (1707), Typhoon Hato(1713), Severe Tropical Storm Pakhar (1714), Severe Tropical Storm Mawar (1716), Typhoon Doksuri (1719), Tropical Depression (no name) and Typhoon Khanun (1720). Their tracks and periods of hoisting of Tropical Cyclone Signals are shown in Figure 1 and Table 1 respectively.

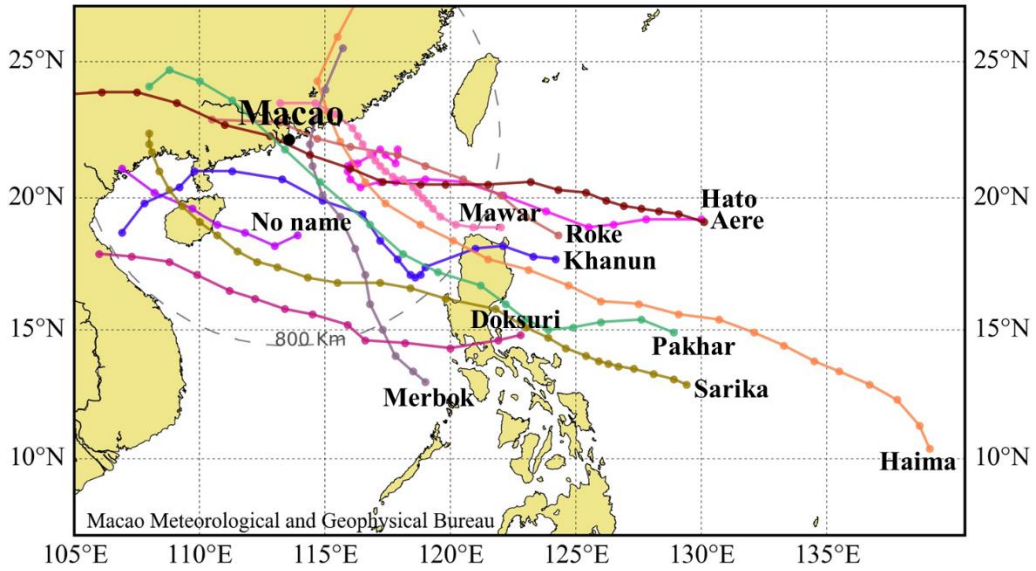

Figure 1 *Tropical cyclone tracks that affected Macao, China since Oct. 2016.*

Three tropical cyclones affected Macao from October to December 2016. The Signal No.8 (Gale Wind Signal) was issued during the passage of Typhoon Haima and was the highest Tropical Cyclone Signals issued in 2016.

In 2017, the typhoon season in Macao started since Jun. 11. Typhoon Hato, Severe Tropical Storm Pakhar and Typhoon Khanun necessitated the issuance of Signal No.8 or above in Macao.

Typhoon Hato was the strongest of the tropical cyclones which struck Macao in the since 1953, and it was also the first time of hoisting Signal No.10 (Hurricane Wind Signal) by Macao Meteorological and Geophysical Bureau (hereinafter referred to as SMG) in the last 18 years. The maximum mean winds recorded at cross-sea bridge (PS station) was 132 km/h with a record-breaking gusts of 217.4 km/h (as

shown in Table 2). Serious flooding were reported in various districts. At the noon, the high tide, together with the storm surge induced by Hato, caused sea levels to rise nearly 3 meters above normal tide levels. A high water level over 2 meters above road had been recorded in the Inner Harbor.

Table 1 *The Tropical Cyclone Signals issued by Macao Meteorological and Geophysical Bureau during the tropical cyclones affected period.*

Start Date	End Date	Name	The Highest Signal
Oct. 7 ,2016	Oct. 9 ,2016	Aere	No. 1
Oct. 16 ,2016	Oct. 19 ,2016	Sarika	No. 3
Oct. 20 ,2016	Oct. 21 ,2016	Haima	No. 8
Jun. 11, 2017	Jun. 13, 2017	Merbok	No. 3
Jul. 22, 2017	Jul. 23, 2017	Roke	No. 1
Aug. 22, 2017	Aug. 23, 2017	Hato	No. 10
Aug. 26, 2017	Aug. 27, 2017	Pakhar	No. 8
Aug. 31, 2017	Sep. 4, 2017	Mawar	No. 1
Sep. 13, 2017	Sep. 15, 2017	Doksuri	No. 1
Sep. 24, 2017	Sep. 25, 2017	Tropical Depression	No. 1
Oct. 13, 2017	Oct. 15, 2017	Khanun	No. 8

Table 2 *Extreme values recorded during the passage of Typhoon Hato.*

Minimum Station Pressure	Maximum Wind Speed	Maximum Gust
945.4hPa (TG station)	132 km/h (PS station)	217.4 km/h (TG station)

During the recovering from the Typhoon Hato, Severe Tropical Storm Pakhar approached Macao four days after Typhoon Hato. The SMG issued Signal No.8 on Aug. 27. Pakhar brought heavy rain and gale winds to Macao. The maximum mean winds recorded was 88.6 km/h with a gusts of 117 km/h at PS station.

Typhoon Khanun was the eighth tropical cyclone which affected Macao this year. The SMG issued Signal No.8 in Oct. 15 morning as Khanun got close to Macao. The actual tide was more than 1 meter above normal tide levels. During the occurrence of high tide in Oct. 15 night, flooding happened in some low-lying areas.

2. Hydrological Assessment

Nil.

3. Socio-Economic Assessment

Macao was hit by six tropical cyclones from Jan. to 15 Sep. in 2017, unfortunately two of them was strong enough to merit the hoisting of Signal No. 8. Typhoon Hato was the greatest disaster that occurs in Macao since 1953 and it caused Macao get into a great trouble. During the passage of Hato, 10 people were killed and 47 were injured. Furthermore, a combination of Typhoon Hato and high tides that caused 64 severe flooding in low-lying areas, causing a city-wide blackout, water supply stoppages and telecommunication breakdowns, also, 11 public carparks and the bus stop station located in the Border Gate were flooded and closed. According to the Fire Services Bureau, the Public Security Police Force and the Customs of Macao SAR, there were total 982 incidents caused by the typhoon, including a total of 129 roadside trees fell down, 457 cases of billboards and windows collapsed or tottering and 264 of other incidents. Furthermore, Typhoon Hato also shut down ferry services and caused 80 flights to be delayed or cancelled. Passengers were stranded at the International Airport and the Outer Harbor Ferry Terminal.

4 Rainstorm Warnings were issued in 2017. Table 4 shows that the downpour caused minor damages to Macao.

Table 3 *Damages caused by tropical cyclones in Macao from Jan. to 15 Sep. in 2017.*

Date/Time		Name	T	Incidents (cases)										
Start	End			Flooding	Landslide	Felled Trees	Walls (Collapsed / Tottering)	Billboards/ Awnings/ Windows/ (Collapsed/ Tottering)	Scaffoldings/ Fencings/ Crane (Collapsed/ Tottering)	Power cables/ Lampposts (Collapsed/ Tottering)	Injuries	Death	Others
11-06-17 21H30	13-06-17 04H40	Merbok (1702)	3	0	0	0	0	0	0	0	1	0	1
22-07-17 17H30	23-07-17 20H45	Roke (1707)	1	0	0	0	0	0	0	0	0	0	0
22-08-17 11H00	23-08-17 21H30	Hato (1713)	10	64	2	129	4	457	26	36	47	10	264
26-08-17 11H30	27-08-17 22H00	Pakhar (1714)	8	15	2	16	0	84	1	13	10	0	35
31-08-17 18H54	04-09-17 15H30	Mawar (1716)	1	5	0	0	0	0	0	0	0	0	3
13-09-17 17H10	15-09-17 06H30	Doksuri (1719)	1	0	0	0	0	0	0	0	0	0	2

Table 4 *Damages caused by rainstorms during 2017.*

Date/Time		Incidents (cases)									
Start	End	Flooding	Felled Trees	Buildings collapsed/ Concrete spalling	Billboards collapsed or tottering	Scaffoldings collapsed or tottering	Windows collapsed or tottering	Awnings collapsed or tottering	Landslide	Deaths / Injuries	Others
16-06-2017 23H33	17-06-2017 03H05	0	0	0	0	0	0	0	0	0	0
04-07-2017 12H55	04-07-2017 14H15	2	0	0	0	0	0	0	0	0	1
06-08-2017 14H28	06-08-2017 15H30	8	1	0	0	0	0	0	0	0	1
04-09-2017 03H30	04-09-2017 10H15	27	0	0	0	0	0	0	0	0	7

4. Regional Cooperation Assessment

4th International Workshop on Tropical Cyclone Landfall Processes (IWTCLP-4) will be held in Macao, China during December 5 – 8, 2017. The theme of IWTCLP-4 is "TC Landfall Impacts: Transitioning from Observations and Modeling to Greater Understanding and Better Forecasts". The IWTCLP is a component of WMO major quadrennial symposia and workshops under the World Weather Research Programme (WWRP). This workshop is in response to the CAS guidance that WWRP, through focused research activities, work on improving the accuracy, lead time and utilization of weather prediction to advance society's ability to cope with high impact weather. The hosting of this workshop was one of the SMG's ongoing contributions to the international meteorological community.

II. Summary of Progress in Priorities supporting Key Result Areas

1. Improve the Information-release Mechanism

Main text:

In order to enhance public awareness of severe weather, especial the striking of tropical cyclones, the SMG always try the best in optimizing its warning system for severe weathers. In order to strengthen the communication and coordination with relevant departments, media and the general public, pre-warning messages are issued in different format, such as text, audio and video. Furthermore, a dedicated webpage is provided to the media for their immediate access to the current weather situation, especially severe weather warnings. Messages and reports, especially those about tropical cyclones, will be revised in order to provide more detailed and wider information to the general public, for their better understanding of the current weather scenario, enhancement of their awareness of the severe weather and taking of safety action.

Identified opportunities/challenges, if any, for further development or collaboration:

Nil.

Priority Areas Addressed:

KRA 2: Enhance capacity to generate and provide accurate, timely and understandable information using multi-hazard impact-based forecasts and risk-based warnings.

KRA 4: Strengthen typhoon-related disaster risk reduction activities in various sectors, including increased community-based resiliency with better response, communication, and information sharing capability.

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2. **Producing Videos to Enhance Public Awareness on Tropical Cyclone-related Hazards**

Main text:

Short educational videos on tropical cyclone-related hazards will be released to raise the public awareness of the threats from tropical cyclones. These videos will introduce major threats caused by tropical cyclones, including strong winds, heavy shows, flooding and storm surge. More educational videos will be released to enhance public awareness of the hazards of other severe weather.

Identified opportunities/challenges, if any, for further development or collaboration:

Nil.

Priority Areas Addressed:

KRA 4: Strengthen typhoon-related disaster risk reduction activities in various sectors, including increased community-based resiliency with better response, communication, and information sharing capability.

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3. Operational Use of SWIRLS

Main text:

Macao Meteorological and Geophysical Bureau has put “Short-range Warning of Intense Rainstorms in Localized System (SWIRLS)”, operated and developed by Hong Kong Observatory, into operational use. SWIRLS provides short-range quantitative precipitation forecast (QPF), which can be used as an additional reference for forecast of rainfall, the base of rainstorm analysis and forecast and the issue of the precaution message and Rainstorm Warning.

Identified opportunities/challenges, if any, for further development or collaboration:

Nil.

Priority Areas Addressed:

KRA 2: Enhance capacity to generate and provide accurate, timely and understandable information using multi-hazard impact-based forecasts and risk-based warnings.

KRA 3: Improve typhoon-related flood control measures and integrated water resource management.

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4. **Optimizing SMG App and "WeChat" Services**

Main text:

By means of the utilization of the "WeChat" social network, the SMG has upgraded its services through providing the latest weather information, including weather warnings, weather forecasts, air quality forecasts, tropical cyclone information, and so on. Information can be delivered to recipients by pushing and recipients' browsing through the provided interface. Furthermore, the procedure of message pushing of APPS and WeChat have also been improved and simplified (automated).

Identified opportunities/challenges, if any, for further development or collaboration:

Nil.

Priority Areas Addressed:

KRA 2: Enhance capacity to generate and provide accurate, timely and understandable information using multi-hazard impact-based forecasts and risk-based warnings.

KRA 4: Strengthen typhoon-related disaster risk reduction activities in various sectors, including increased community-based resiliency with better response, communication, and information sharing capability.

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5. **Launched an Objective Hourly Forecasts**

Main text:

The SMG has launched an objective hourly forecasts for the upcoming 48 hours, which tends to better facilitate the general public about the planning for their day, and take an hour-by-hour look at the weather for the upcoming 48 hours. At the first stage, we focused on temperature and humidity forecasts only. More elements have been added continuously and being tested internally. We tend to provide more information to the public ASAP. The evaluation and calibration effort is continuously ongoing.

Identified opportunities/challenges, if any, for further development or collaboration:

Nil.

Priority Areas Addressed:

KRA 2: Enhance capacity to generate and provide accurate, timely and understandable information using multi-hazard impact-based forecasts and risk-based warnings.

KRA 4: Strengthen typhoon-related disaster risk reduction activities in various sectors, including increased community-based resiliency with better response, communication, and information sharing capability.

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6. Enhanced Students Science-education

Main text:

To increase the knowledge and interest of students in meteorology, SMG gives lectures on different topics in schools every year, each topic will be prepared in two versions, one for primary schools and the other for secondary schools. Schools can choose between Chinese, Portuguese and English as their preferred language for lectures. To comply with the schools' schedule, the lectures covered 7 topics (e.g., tropical cyclone, rainstorm, climate change) this year and were arranged from October 2016 to May 2017.There were over 3,400 students from 20 schools registered for the lectures, and the lectures have been ongoing in different schools.

Identified opportunities/challenges, if any, for further development or collaboration:

Nil.

Priority Areas Addressed:

KRA 4: Strengthen typhoon-related disaster risk reduction activities in various sectors, including increased community-based resiliency with better response, communication, and information sharing capability.

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7. The Civil Protection Operation Centre was Established on 23 March 2017

Main text:

The Macao SAR Government had established a new centre named the Civil Protection Operation Centre on 23rd March 2017 (Figure 2) which belongs to the Unitary Police Service (hereinafter referred to as SPU). It consists of 29 different entities, which include the centre itself, 9 military force and security departments, 13 public sectors and 7 private companies. It aims to prevent dangers happen caused by serious accidents and disasters; minimize the danger and its result; rescue and helping those suffer in danger. The centre will open when there are serious incidents happen in Macao, such as typhoons hoisted above Signal No. 8 The public can call to the centre if they are in need, the commander will contact responsive people to handle the case immediately (Figure 3). Furthermore, the Civil Protection and Coordinate Centre had offered each member a walkie-talkie with the same channel, once the centre opens, they can share the information with each other and report to the Civil Protection Operation Centre, then the centre can know the situation of Macao, the commander can think of the settlement immediately and place order. During Typhoon Hato, the centre was opened for almost one month. Since the centre was just established for 3 months and Typhoon Hato was so serious that the commander and the people responding had been non-stop working for more than 48 hours. Fortunately, the operation was running smoothly. Although typhoon Hato had landed, the centre was keep operating to handle for the remaining stuffs. All the members of the civil protection send representative to the centre to solve the problems and share their resources. In total, the centre had received around 1400 calls and handles 982 incidents during Typhoon Hato.

Identified opportunities/challenges, if any, for further development or collaboration:

For every typhoon season, the Macao SAR Government needs to focus more on forecasting the typhoon weather. Once announce typhoon Signal No. 8 will be hoisted, the centre will open and the representatives of the Civil Protection are required to arrive the centre within 2 hours, that’s why the forecast of the SMG is very important. The SMG needs to analysis the typhoon accurate and as early as possible.

The typhoon season in Macao is mainly on May to September, however, the Macao SAR Government need to do many preparations before the typhoon season so as to respond to the coming season. The Civil Protection and Coordinate Centre will coordinate some practices related to the typhoon issues to let the members of the

Civil Protection to join. Also, the SPU will hold meetings with the members and the related unit to discuss the measures for responding to the typhoon.

Priority Areas Addressed:

KRA 4: Strengthen typhoon-related disaster risk reduction activities in various sectors, including increased community-based resiliency with better response, communication, and information sharing capability.

KRA 1: Enhance capacity to monitor mortality and direct economic loss caused by typhoon-related disasters.

KRA 2: Enhance capacity to generate and provide accurate, timely and understandable information using multi-hazard impact-based forecasts and risk-based warnings

KRA 3: Improve typhoon-related flood control measures and integrated water resource management.

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8. Disaster Risk Reduction

Main text:

Landslides prevention is one of the greatest concerns for Macao SAR Government, so Land, Public Works and Transport Bureau (DSSOPT), Civic and Municipal Affairs Bureau (IACM) and Macau Laboratory of Civil Engineering (LECM) was comprised together, named Slope Safety Working Group. Their responsibilities are to conduct regular inspection and survey of slopes; eliminate the risk of landslides; slope reinforcement and maintenance and preparing annual assessment reports. However the number of medium risk slopes is increased from 45 to 52 in 2017 and the number of low risk slopes is also increased too. Although those slopes will not have immediate danger, but the Bureau will continue monitor on them, make maintenance if necessary in order to ensure that they are in stable condition.

The following table demonstrates the distribution of slopes in Macao according to landslide risk level.

Table 5 *Distribution of slopes in Macao according to the landslide risk level.*

	High Risk	**Medium Risk**	**Low Risk**	**Total**
Macao Peninsula	1	19	65	85
Taipa	1	18	43	62
Coloane	0	15	52	67
Total	2	52	160	214

Furthermore, the DSSOPT and the Cartography and Cadastre Bureau (DSCC) have built up a "Slope Safety Information Network" website, the public can check the state of the slopes and the risk level through the website easily. Besides, the owner can learn about the risk level of the slope, to take up the responsibility of maintenance and reinforcement of the slope, so as to minimize the risk. In addition, the Bureau is working on the reinforcement of one slope in Taipa in 2017, there are six methods that the Bureau use to reinforce the slopes (Figure 4). The Bureau will base on the location, geology, shape and the risk of the slope to match with suitable method.

For the flooding problems, it is usually another great concern for the Macao SAR Government and the citizens. The DSSOPT is keep on reinforcing and adding new drainages in order to solve the problem. Since Taipa City is developing in a fast speed and being urbanization, and the rainfall is increasing highly, that's why the DSSOPT had changed some path of the drainages and keep reinforcing them to

reduce the pressure of main drainages. Also, the DSSOPT had constructed a new drainage under the Taipa Hill (Figure 5), to collect rainwater from the Taipa Hill and eventually discharge to the sea. This can prevent a heavy amount of rainwater flowing into Taipa city and will hence improve the flooding situation there. In addition, including the new drainages in Taipa, the DSSOPT had constructed a total of 6 new drainages and reinforced 1 drainage in 2017.

Last but not the least, the Civic and Municipal Bureau (IACM) had removed 565 dangerous tress and trimmed over 10000 trees in 2017 to prevent the death and serious injury from falling trees and branches. Moreover, the IACM and the Fire Service Bureau had removed a total of 37 signboards and 37 billboards that were considered “potentially dangerous”.

Identified opportunities/challenges, if any, for further development or collaboration:
Nil.

Priority Areas Addressed:
KRA 3: Improve typhoon-related flood control measures and integrated water resource management.

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9. Drill and Emergency Plan with Government Departments and Organizations in Preparation for Severe Weather

Main text:

Macao Civil Protection and Coordination Centre will stage an annual typhoon drill every year to test coordination and communication among members in dealing with typhoon-related incidents, 29 public and private entities will participate in the drill. In 2017, an annual drill was conducted in April which simulated the hoisting of typhoon Signal No. 8. Furthermore, with the establishment of the Civil Protection Centre in Taipa, the Macao Civil Protection and Coordination Centre has staged another typhoon exercise (Flamingo) to test the new functional facilities in the new centre, such as the RGT system and the operating of CCTV. Also, the drill tested the operating of the hardware in the centre and the members' response under the leading of the commander (COPC) and the deputy commander (COI). The drill involved 1179 participants from 27 public and private entities, stimulated 14 incidents for the participants to handle (Figure 6).

Identified opportunities/challenges, if any, for further development or collaboration:

Nil.

Priority Areas Addressed:

Planning to improve the emergency plan and adding more members to the civil protection structure. In the coming years, we plan to increase and improve the frequency and level of difficulties of the drills.

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10. Strengthen Resilience of Communities to Typhoon-related Disasters

Main text:

The Unitary Police Service (SPU) will hold regular meetings with the 27 public and private entities to discuss options and exchange opinions on how to improve Macao's typhoon-related problems. In April, the 27 members had grouped together to discuss and improved the emergency rescue mechanism so as to well prepare for the coming typhoon season. In the meeting, the Meteorological and Geophysics Bureau, Education and Youth Affairs Bureau and the Social Welfare Bureau representative had shared their own information and the other members had presented their opinions and suggestions.

Besides, the Macao SAR Government also focuses on the promotion for the citizens and teenagers for disaster prevention. In May, the Marine and Water Bureau comprised with the Customs, Fire Services Bureau, Civil and Municipal Affairs Bureau, Health Bureau and related departments representatives went to the Inner Harbor to do promotion with the fishermen, mainly about wind protection, how to response to sudden incidents happen in the sea. Furthermore, the Judiciary Police also do promotion in the University of Macau with the students there in August.

Last but not the least, the Macao SAR Government has proposed to build flood tidal gates program to reduce the risk of flooding. The Chief Executive of Macao Chui Sai On went to Guangzhou with the Government representatives to have meeting with the Guangzhou Government discussing about the idea of the tidal gates, the initial estimation that the gates will be set in the Inner Habour. (Figure 7)

Identified opportunities/challenges, if any, for further development or collaboration:

Nil.

Priority Areas Addressed:

KRA 4: Strengthen typhoon-related disaster risk reduction activities in various sectors, including increased community-based resiliency with better response, communication, and information sharing capability.

KRA 2: Enhance capacity to generate and provide accurate, timely and understandable information using multi-hazard impact-based forecasts and risk-based warnings

KRA 3: Improve typhoon-related flood control measures and integrated water resource management.

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11. **Improved Capacity to Generate and Provide Accurate, Timely and Understandable Information on Typhoon-related Threats**

Main text:

In the short-term planning, the Macao SAR Government plans to set up a broadcasting system along the low-lying areas and the main ports such as the Border Gate, Outer Harbor and the airport. This can let the citizens and the travelers know about the warning message of the bad weather and further its situation. Besides, the SPU plans to create a typhoon and disaster message database and set up a message deliver workgroup to increase the efficiency of delivering messages.

Also, since the electronic product is so common now, the SMG has launched an apps which the Bureau will deliver weather-related message to the public regularly, such as daily weather, thunderstorm warning and strong monsoon signal. The SPU will also update the new weather condition to its website when there is typhoon hoisted.

Identified opportunities/challenges, if any, for further development or collaboration:

Nil.

Priority Areas Addressed:

KRA 4: Strengthen typhoon-related disaster risk reduction activities in various sectors, including increased community-based resiliency with better response, communication, and information sharing capability.

KRA 2: Enhance capacity to generate and provide accurate, timely and understandable information using multi-hazard impact-based forecasts and risk-based warnings

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12. Enhanced Typhoon Committee's Effectiveness and International Collaboration

Main text:

In 2017, The SPU delegated representative to participants in the meetings organized by Typhoon Committee as well as TC Working Groups. These include the 49th Session of Typhoon Committee held in Yokohama, Japan.

Identified opportunities/challenges, if any, for further development or collaboration:

Nil.

Priority Areas Addressed:

KRA 5: Enhance Typhoon Committee's Regional and International collaboration mechanism.

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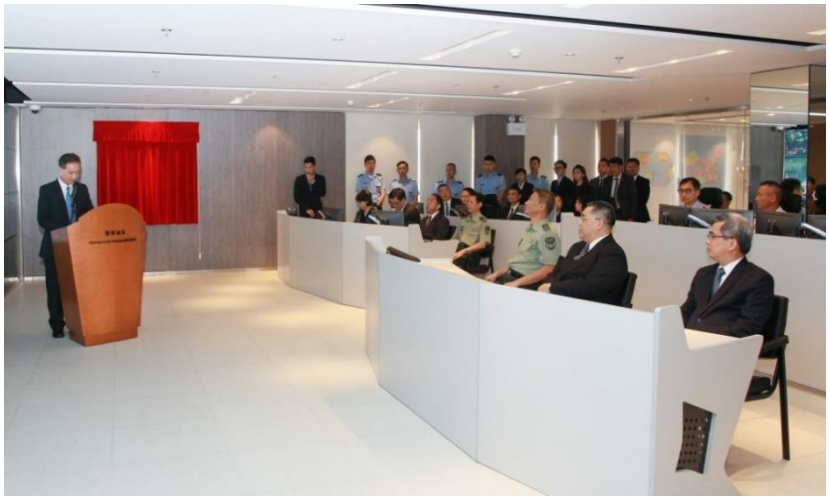

Figure 2 *A number of major guests and 27 civil protection members attend the opening.*

Figure 3 *The group is answering the incoming calls and settling the incidents.*

Figure 4 *Six methods of reinforcing the slopes.*

Figure 5 *Building a new drainage system in the Taipa Hill to bypass the rainwater.*

Figure 6 *The 27 entities participate in the practice of "Flamingo".*

Figure 7 *Chui Sai On went to Guangzhou with the Government representatives to have meeting with the Guangzhou Government.*