

MEMBER REPORT

Macao, China

ESCAP/WMO Typhoon Committee
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CONTENTS

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

1. Meteorological Assessment
2. Hydrological Assessment
3. Socio-Economic Assessment
4. Regional Cooperation Assessment

II. Summary of Progress in Priorities supporting Key Result Areas

1. Revision of the Executive Orders related to "Rainstorm Warning Signal System"
2. Enhanced public weather service
3. Promotion the knowledge of meteorology and disaster risk reduction
4. Personnel capacity-building
5. Hardware capacity-building
6. Improving operational system for tropical cyclone forecast
7. High Ground Alarm and Alarm and Broadcast for Low-lying Areas
8. Drill and Emergency Plan with Government Departments and Organizations in Preparation for Severe Weather

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

1. Meteorological Assessment

Six tropical cyclones affected Macau, China between Oct 2018 to Sep 2019, including Severe Tropical Storm Yutu (1826), Tropical Storm Mun (1904), Tropical Storm Wipha (1907), Severe Tropical Storm Bailu (1911), Tropical Storm Podul (1912) and a Tropical Depression Kajiki (1914). Their tracks and the issued Tropical Cyclone Signals in Macau are shown in fig. 1 and table 1 respectively. The meteorological influences on Macau are described below in detail.

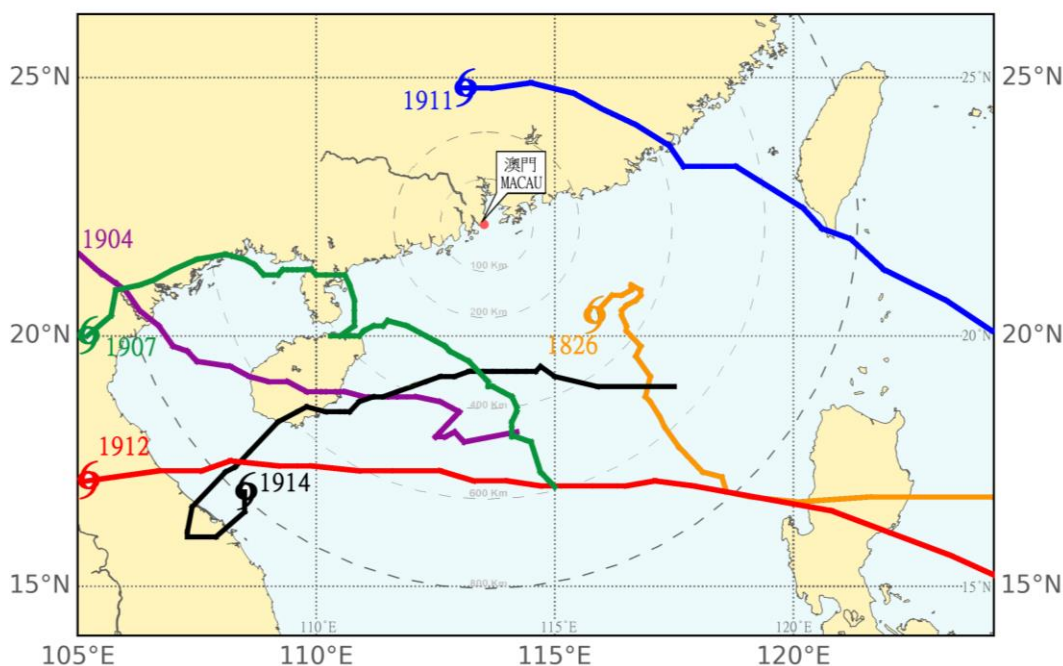


Figure 1 Tropical cyclone tracks that affected Macao, China between Oct 2018 to Sep 2019.

Severe Tropical Storm Yutu (1826)

Yutu was formed over the northwestern Pacific and once intensified into a super typhoon, but it finally weakened as a severe tropical storm after it came across the Luzon islands. It entered the 800km alert radius of Macau on Oct 31. Since it kept weakening over the northeastern part of the South China Sea, its influence on Macau was minimal. Under the joint effect of Yutu and the northeast monsoon, the maximum mean winds were recorded as 42 km/hr for only a while.

Tropical Storm Mun (1904)

Mun was formed and named on the South China Sea. It moved westwards and kept a distance over 400km from Macau. However, while its outer rainbands were passing Macau, the mean winds of force 6 were recorded in Macau. Mun was the first tropical cyclone that affected Macau in 2019. It led to the first Tropical Cyclone Signal no.1 and no.3 in 2019 in Macau. At the same time, under the joint effect of Mun and astronomical tide, the blue storm surge warning, the first storm surge warning in 2019, was also issued. There were light floodings in low-lying areas for several mornings.

Tropical Storm Wipha (1907)

Wipha was developed over the central and the northern part of the South China Sea. It came closest to Macau on July 31 night, about 270km southwest of Macau, and rainbands over its northern quadrant brought squally showers to Macau. The maximum mean winds were recorded as 67 km/hr. Meanwhile, under the joint effect of strong winds and astronomical tide, 0.5m flooding level was recorded. Due to the impact by Wipha, the first Tropical Cyclone Signal no.8 and the yellow storm surge warning in 2019 in Macau were issued.

Severe Tropical Storm Bailu (1911)

Since the track of Bailu was towards the eastern coastal areas of Guangdong, its impact on Macau was minimal. Under the influence of its outer subsidence air, it was very hot in Macau on Aug 24. The maximum temperature of 35°C was recorded.

Tropical Storm Podul (1912)

The impact of Podul to Macau was minimal due to its weak intensity and a far distance to Macau, but there was still a short period of time that the mean winds of force 7 were recorded while the outer rainbands of Podul were passing Macau. In addition, there were light floodings in low-lying areas on Aug 29 under the joint effect of astronomical tide and the circulation of Podul.

Tropical Depression Kajiki (1914)

Kajiki moved westwards across the northern part of the South China Sea at first and it came closest to Macau on Sep 1, about 320km south of Macau. Meanwhile, there were squally showers in Macau. The mean winds of force 6 were recorded with maximum gusts 79km/h. Though Kajiki twisted back to the South China Sea again after it had made landfall in Vietnam, no threat was made to Macau as it finally weakened and dissipated over the South China Sea.

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 31, 2018	Nov 02, 2018	Yutu	No. 1
Jul 01, 2019	Jul 03, 2019	Mun	No. 3
Jul 30, 2019	Aug 02, 2019	Wipha	No. 8
Aug 24, 2019	Aug 25, 2019	Bailu	No. 1
Aug 28, 2019	Aug 29, 2019	Podul	No. 1
Sep 01, 2019	Sep 03, 2019	Kajiki	No. 3

2. Hydrological Assessment

Nil.

3. Socio-Economic Assessment

Macao was hit by six tropical cyclones between Oct 2018 to Sep 2019, while only one of them was strong enough to merit the hoisting of typhoon signal no. 8. Although the typhoon Wipha had reached the typhoon signal no. 8, the damage was little. Also, from table 2 we can see that there was only one case of flooding happen in downtown areas. Comparing with the typhoons in 2017 and 2018, the strength and the central wind of typhoons in 2019 is plesser than the past two years.

During the passage of Wipha, according to the Fire Services Bureau, the Public Security Police Force and the Customs of Macao SAR, there were a total of 22 incidents caused, including a total of 4 tress fallen, 1 billboard collapsed and 6 people were injured, etc.

Ten rainstorm warnings were issued in 2019. Table 3 shows that the downpour caused minor damages to Macao. Referring to the following table, the heavy downpour in April and May triggered flooding and landslide in various places across Macao, some roads were temporarily closed to traffic because of rain-triggered landslide.

Also, when there is a great amount of rainfall, flooding will occur in low-lying areas. The Macao SAR is making lots of related measures to solve this problem.

Table 2 Damages caused by tropical cyclones in Macao between Oct 2018 to Sep 2019.

Date/Time		Name	The Highest Signal Hoisted	Incidents (cases)									
Start	End			Flooding	Landslide	Fallen Trees	Walls (Collapsed/Tottered)	Billboards/Awnings/Windows/ (Collapsed/Tottered)	Scaffolding s/ Fencings/ Crane (Collapsed/Tottered)	Power cables/ Lampposts (Collapsed/Tottered)	Injuries	Death	Others
31-10-18 10H00	02-11-18 07H00	Yutu (1826)	1	0	0	0	0	0	0	0	0	0	0
01-07-19 22H00	03-07-19 13H00	Mun (1904)	3	0	0	0	0	0	0	0	0	0	0
30-07-19 12H30	02-08-19 12H30	Wipha (1907)	8	0	0	4	0	1	1	0	6	0	10
24-08-19 17H30	25-08-19 20H00	Bailu (1911)	1	0	0	0	0	0	0	0	0	0	0
28-08-19 15H00	29-08-19 15H30	Podul (1912)	1	1	0	0	0	0	0	0	0	0	2
01-09-19 09H30	03-09-19 11H00	Kajiki (1914)	3	0	0	0	0	0	0	0	0	0	0

Table 3 Damages caused by rainstorms during 2019.

Date/Time		Incidents (cases)										
Start	End	Flooding	Fallen Trees	Buildings collapsed/ Concrete spalled off	Billboards collapsed or tottered	Scaffolding collapsed or tottered	Windows collapsed or tottered	Awnings collapsed or tottered	Landslide	Deaths / Injuries	Others	
05-03-2019 00H52	05-03-2019 02H45	0	0	0	0	0	0	0	0	0	0	
14-04-2019 14H05	14-04-2019 15H00	0	1	0	0	0	0	0	0	4	0	
18-04-2019 18H50	18-04-2019 21H30	0	0	0	0	0	0	0	1	0	1	
20-04-2019 13H55	20-04-2019 16H30	6	0	3	0	1	0	0	0	1	1	
27-05-2019 09H10	27-05-2019 11H10	0	0	0	0	0	0	0	0	3	3	
28-05-2019 05H40	28-05-2019 09H30	2	0	0	0	0	0	0	1	2	0	

Table 3 Damages caused by rainstorms during 2019(cont.)

13-06-2019 15H00	13-06-2019 15H00	0	0	0	0	0	0	0	0	0	0
02-08-2019 13H40	02-08-2019 16H15	6	0	0	0	0	0	0	0	2	4
12-08-2019 16H35	12-08-2019 17H35	0	0	0	0	0	0	0	0	0	0
26-08-2019 01H10	26-08-2019 06H00	1	0	0	0	0	0	0	0	0	1

4. Regional Cooperation Assessment

An expert meeting was held for WGM AOP “The third assessment report on the Climate Change Impacts on Tropical Cyclones in the Typhoon Committee region (TCAR3)” on 26th and 27th Nov 2018 in Macao (fig.2) successfully. Experts from China, Hong Kong, China, USA, Japan and Korea were invited, and they shared their process as well as the opinion on the compilation of the report. It is an honor for SMG, the coordinator of the project, to host this meeting.

The TCAR3 is under a smooth progress in 2019. Experts keep paying great effort on finishing the report. The draft of the TCAR3 was finished in Sep this year, and it was circulated to all Typhoon Committee members in Oct. After collected the comments from members, the TCAR3 is expected to be published by the end of 2019.



Figure 2 The Expert Meeting of TCAR3 held in Macao in Nov 2018.

II. Summary of Progress in Priorities supporting Key Result Areas

1. Revision of the Executive Orders related to “Rainstorm Warning Signal System”

Main text:

The Executive Orders related to “Rainstorm Warning Signal System” are being revised this year and expected to be effective at the beginning of next year. The main difference between the new system and the original one is that the levels of Rainstorm Warning Signal increase to three levels for the public to take the suitable precaution accordingly.

Meanwhile, since heavy rainfall can lead to numerous hazards to us, such as flooding, disruption of transportation and communications. Incidences of heavy rainfall seem to affect Macao citizen in a way that early precaution or advices is definitely very important. Therefore, before the new system of “Rainstorm Warning Signal System” is applied, a 20mm heavy rain tips (fig.3) has been released such that general public can have a better understanding about the current scenario, prior to the issuance of the rainstorm warnings if necessary.

Besides, SMG also enhance the release of reminder, precaution and information of severe weather to the public for better preparation against severe weather.



Figure 3 Icon of 20mm heavy rain tips.

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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2. Enhanced public weather service

Main text:

To better enhance our public weather service, we have revamped our official website, along with the optimization of our APP. The experience version of our new website (fig.4) has been launched in September 2019, together with the release of the Android version (APK) of our new APP on the same day. The design of this new website enables a higher level of usability, stability, functionality and accessibility for the delivering of meteorological information to the public, especially severe weather warnings. Associated information will be bundled along with the warnings such that citizens can easily understand and gather the related meteorological data that is related to that specific phenomenon. We expect this new look and feel of our website enables a better delivery of meteorological information, as well as severe weather warnings, to the general public. In regards to our new APP, a complete enhancement has been made, to ensure that more meteorological information or warnings, or even precautions to weather phenomenon can be sent at ease.

Moreover, our WeChat account has also been upgraded such that severe warnings can be seen at ease. Since “WeChat” is a mobile app which could be found in various mobile operating system, such as the iOS and Android, we believe that by providing meteorological information through its broadcasting mechanism can better enhance the awareness and preparedness of the public, especially during tropical cyclones and rainstorm scenario. Needless to say that promotion of new services has been done in this effective channel as well.



Figure 4 New official SMG website, launched in Sep 2019.

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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3. Promotion the knowledge of meteorology and disaster risk reduction

Main text:

Short videos related to tropical cyclone and storm surge were released to raise the public awareness. These videos introduce the precaution against the said severe weather phenomenon. Furthermore, SMG also cooperate with Macao Science Center in the production of a series of short films concerning weather forecasting, especial those about tropical cyclones.

Nowadays, STEM education become more popular. Macao Science Center and SMG co-hosted an APP programming competition for the promotion of knowledge about meteorology, DDR and programming .

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. More than 4500 students attended the lectures, and the lectures have been ongoing in different schools (fig.5). Furthermore, several open seminar on tropical cyclone, storm surge, the new warning system as risk reduction were also held throughout the year.

Figure 5 Lectures of severe weather for secondary and primary school students.



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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4. Personnel capacity-building

Main text:

In order to promote the ability of the meteorological staffs, SMG staffs were sent to different on-job training, workshops and seminar. These included:

- i. Sending weather forecaster to nearby regions for on-job training
- ii. Attending different workshops and seminars, such as TC Roving Seminar, IWS etc.



Figure 6 Training at (a) Guangdong Meteorological Service, and (b) China Meteorological Administration.

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. Hardware capacity-building

Main text:

New AWSs and water level monitoring stations will be constructed to enhance the monitoring of meteorological element and flooding over Macao. Further, a new real time lightning monitoring system was introduced into SMG for better monitoring of lightning in nearby region.

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 and integrated water resource management.

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. Improving operational system for tropical cyclone forecast:

Main text:

In order to improve the operational system for tropical cyclone forecast. SMG introduced the Tropical Operating System (TOS), which is developed by Korean Meteorological Administration (KMA). TOS is a system for analysis, forecast and statistics of tropical cyclones. Experts from National Typhoon Center (NTC) of KMA visited Macao for transfer of technology, which include the installation and setup of the system, in mid-October (fig.7). On site lectures and practice, which covered overall structure of the system as well as management of data of tropical cyclones, were also provided to the local forecasters to make them to be familiar to the procedures of generation of typhoon reports through TOS.

Besides, SMG plans to develop an analysis integrated system for tropical cyclone and storm surge. It will collect and display different numerical simulation results, predicted tracks and storm surge simulations. It is designed to unify different kinds of data in a simple, friendly-use interface for users to recall useful information easily.



Figure 7 TOS on site training.

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

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7. High Ground Alarm and Alarm and Broadcast Alert for Low-lying Areas

Main text:

Under the coordination of the Unitary Police Service, the Macao SAR has set up a “Storm Surge Evacuation Plan in Low-lying Areas During Typhoon”. Based on the plan, the Macao SAR has set up an alarm and broadcast alert for citizens. When a storm surge comes, the low-lying areas will receive a special audio from the alarm to remind the citizen that the storm surge is coming.

In order to strengthen the distribution channels for early warning messages, the Macao SAR has installed three High Ground Alarms in Macau, one is in the high hill of Macau Peninsula and the other two are located in the other two islands (Taipa and Coloane) (fig.8). Each system covers an area of about two kilometers. There are two types of “Storm Surge Audio Alarm Signals”: Alert Audio Alarm Signal and Emergency Audio Alarm Signal. The Alert Audio Alarm Signal means that when the Meteorological and Geophysical Bureau has issued the third or above level storm surge, residents in low-lying areas may be threatened or affected, the signal will be activated. (Signal is repeated regularly or irregularly according to actual circumstances). Emergency Audio Alarm Signal will be activated when flooding has occurred in low-lying areas and the water level is expected to rise significantly and rapidly within a short period of time.

For the alarm and broadcast in low-lying areas, there are two types of broadcasting. One is moving car broadcasting and the other is the loud speakers on 90 poles installed in the low-lying areas. Each covers about 50 to 100 meters (fig. 8). After the “Storm Surge Audio Alarm Signal” is activated, corresponding alarm broadcast will be made by the “Alarm Broadcasting System for Low-Lying Areas” and Government vehicles. The loudspeakers will issue relevant civil defense

messages in Chinese, Portuguese and English to cater for people of different languages.

By implementing the above measures, the Macau Citizens can better prepare themselves before the storm surge comes. For those who cannot receive the storm surge messages from television or mobile phone, this can be another channel for people receiving the message. This measure can help to increase the coverage of related message sending to people. By receiving these messages, people affected can evacuate to the nearest shelter centres in advance. For those who choose to stay at home, they should prepare necessary food and drinks in advance and not to go out when the pre-warning message is out.



Figure 8 High Ground Alarms and Loud Speakers in Macao SAR. a) One High Ground Alarms located at the high hill of Macau Peninsula. b) Loud Speaker on a pole.

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

Nil.

Priority Areas Addressed:

We are 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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8. Drill and Emergency Plan with Government Departments and Organizations in Preparation for Severe Weather

Main text:

Civil Defence drill in 2019

Every year, the Unitary Police Service will hold an annual meeting relating to the work of the civil protection system in that year and introduction of the annual drill. The 2019 annual meeting was held on 9th April, during the meeting, the representative of the Unitary Police Service introduced the details of the annual drill 2019 and announced the date of the drill to the public. Besides, the representative of the Meteorological and Geophysics Bureau made the meteorological review in 2018 and weather forecast in 2019; The Social Welfare Bureau introduced the facilities and the supplies of the shelter centers. In response to the sharing, all the members of the civil defense structure actively exchanged their views.

The annual drill 2019 was held on 27th April, 2019, named "Crystal Fish 2019". Before the annual drill, on 26th March, 2019, the Unitary Police Service and the members of civil defense structure conduct a table exercise together, as a preparation for the actual exercise in order to make sure that the exercise can run smoothly. The purpose to hold an annual drill is to test the coordination and communication among members in dealing with typhoon-related incidents. By gaining experience from the super typhoon "Mangkhut" last year, comprehensively test the practicality and operability of the "Storm surge evacuation plan in low-lying areas during typhoon" and the "Emergency Command Application Platform", meanwhile examining and strengthening the emergency response of civil defense structure members. Social organizations, construction and machinery organizations and the public were invited to join the exercise, so as to strengthen the ability of disaster prevention and reduction between civil defense structure and the public (fig.9). Through the participating of the public, hope to increase the public awareness of risk prevention and enhance their self-rescue ability.



Figure 9 Evacuation exercise during annual drill “Crystal Fish 2019”.

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

Nil.

Priority Areas Addressed:

We are 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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