MEMBER REPORT
Macao, China

ESCAP/WMO Typhoon Committee

15th Integrated Workshop

Viet Nam

1-2 December 2020

CONTENTS

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

1. Meteorological Assessment

Five tropical cyclones affected Macau, China between Oct 2019 to Nov 2020, including Tropical Storm Nuri (2002), Tropical Storm Sinlaku (2003), Typhoon Higos (2007), Severe Tropical Storm Nangka (2016) and Severe Tropical Storm Saudel (2017). 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.

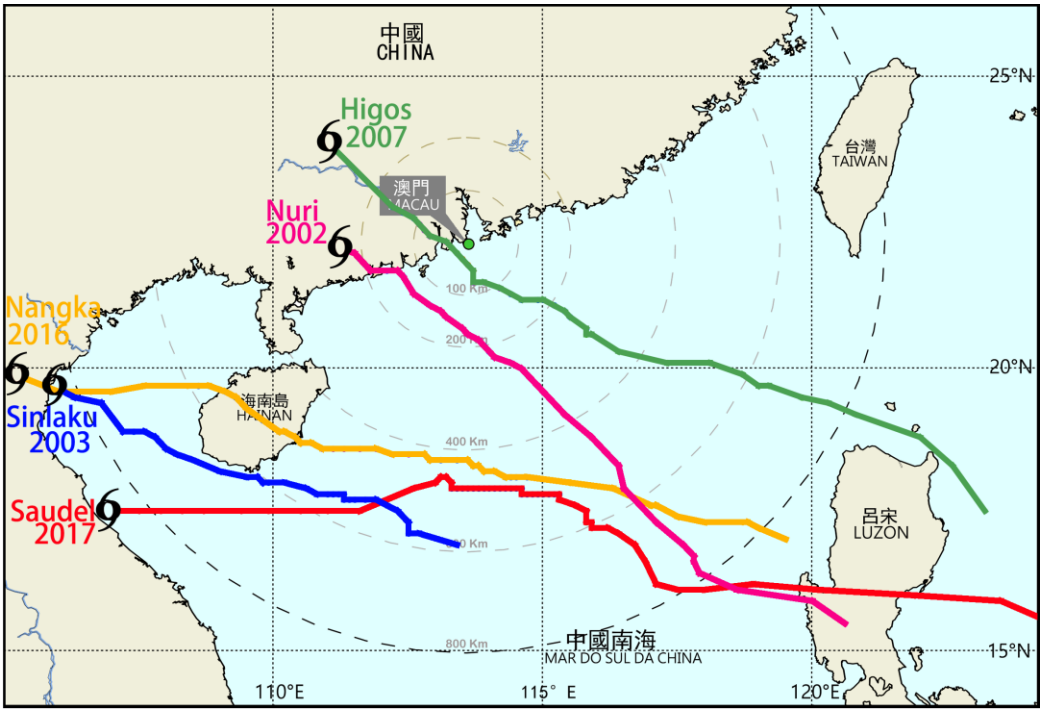

Figure 1 *Tropical cyclone tracks that affected Macao, China between Oct 2019 to Nov 2020.*

Tropical Storm Nuri (2002)

Nuri was formed at the ocean to the east of the Philippines and developed slowly. It entered the 800 km alert zone of Macao on June 12, and was intensified into a tropical storm at night. Though Nuri was intensifying slowly as it moved towards the western Guangdong coastal area, the structure of Nuri was not solid, where the main rain and cloud band remained at the southwest quadrant, with only a few amount of clouds at the northeast quadrant. Nuri remained as a tropical storm and made landfall at Yangjiang of Guangdong in the morning on June 14. It was weakened quickly after landfall and was dissipated at the same night.

Our bureau issued the No.3 signal at the evening of 13 June, Nuri came closest to Macao in the early morning of 14 June, passing a distance of about 140 km SSW of Macao. Nuri didn't cause any significant impact to Macao, and no storm surge was recorded as it was at the low phase of astronomical tide

Tropical Storm Sinlaku (2003)

A monsoon depression was originally developed at the middle of the South China Sea at the end of July 2020, and was moving westward. The southwesterly airstream provided strong moisture supply, thus the convection development was very active, and the circulation of the monsoon depression was very broad covering nearly the whole South China Sea. Sinlaku developed into a tropical depression on 31 July, and further intensified into a tropical storm the next day.

Under the combined influence of the Subtropical High, Sinlaku brought strong wind with wind force 6 to Macao on 31 July even though it was still a monsoon depression. The Strong Monsoon Signal was issued in the morning. When Sinlaku furthered developed into a tropical depression in the afternoon, the Strong Monsoon Signal was replaced by Typhoon signal No.3. It was the first time to issue the typhoon signal No.3 directly without issuance of signal No.1 since 1993.

Sinlaku came closest to Macao at the beginning of 1 Aug, passing a distance of about 530 km SSW of Macao. Though the circulation of Sinlaku was broad, the intensity remained weak and maintained a certain distance away from Macao. Therefore, it didn't bring any significant impact to Macao, with slight flooding of about 0.21 m occurred in the low-lying area of the inner harbor area

Typhoon Higos (2007)

Higos was developed at the east of Luzon Island of Philippines on 16 Aug. It moved steadily towards northwest, entering the South China Sea and moved into the 800 km alert zone of Macao on 17 Aug. Since the conditions were highly favorable for tropical cyclone development, Higos intensified quickly on 18 Aug, where it intensified from a tropical depression into a typhoon within 24 hours. Higos continued to move northwest and made landfall at Zhuhai City of Guangdong at 6 a.m. on 19 Aug. It was also the closest to Macao at the same time, just 20 km southwest of Macao.

The intensity of Higos was much stronger than expected, and moved more northwardly towards Macao. The strong wind and heavy rain near the eyewall directly affected Macao, causing a significant impact. The highest 10-minute mean windspeed recorded was 138.6 km/h, with gust up to 215.6 km/h, and the minimum sea level pressure of 984.8 hPa was recorded at the beginning of 19 Aug. Under the significant impact of Higos, the typhoon signal No.10 was issued. Meanwhile, the time of impact

of Higos was expected to coincide with the astronomical tide, as a result, a significant storm surge with flooding level of 1.5 m – 2.5 m was expected in the low-lying area of the Inner Harbor, resulting in the issuance of red storm surge warning signal. However, since Higos moved faster than expected, the resulted storm surge was staggered with the peak of the astronomical tide, and the maximum flood level 0.82 m was recorded, which was much lower than expected.

Severe Tropical Storm Nangka (2016)

A broad low pressure area was developing to the east of Luzon Island, moved westward and entered the South China Sea on 11 Oct. Later on, it developed into a tropical depression and entered the 800 km alert zone of Macao. It further strengthened into a tropical storm the next day and was named "Nangka". Nangka continued to move WNW towards Hainan Island, and was closest to Macao in the morning on 13 Oct. It passed through about 410 km SSW of Macao, and reached the peak intensity as a severe tropical storm. Nagnka first made landfall at Hainan Island, then entered the sea later on, and made landfall again at north of Vietnam on 14 Oct. Afterwards, it began to weaken and dissipated finally.

Though Nangka remained a distance of about 400 km away from Macao, under the "Accompanied effect" with the northeast monsoon, the confluence flow between Nangka and the northeast monsoon was affecting the coastal area of Guangdong. The winds were strong with wind force up to 8-9 occurred in the PRD area. Therefore, the typhoon signal No.8 was issued by our bureau on 13 Oct, and this was the furthest distance of a tropical cyclone requiring the issuance of signal No.8 since 1970.

Severe Tropical Storm Saudel (2017)

Saudel formed at the eastern ocean of the Philippines, and then intensified into a tropical storm on 20 Oct. It was moving over Luzon Island between 20 and 21 Oct, entered the 800 km alert zone of Macao on 21 Oct at night. Under favorable conditions for development at the South China Sea, Saudel quickly intensified from tropical storm into a typhoon on 23 Aug. Saudel was first moving northwest towards the coastal area of Guangdong, however, under the influence of the continental high at the north, Saudel turned to move westward and accelerated, with the closest distance about 450 km south of Macao. Meanwhile, the dry and cool air from inland caused Saudel to weaken quickly, it finally moved inland of Vietnam and dissipated on 26 Oct.

Under the combined influence of the northeast monsoon and Saudel, the northerlies with wind force 6-7 was persisted in Macao, and the typhoon signal No.3 was issued by our bureau. However, as the strong northeast monsoon predominated

and brought dry and relatively stable weather to the region, only 0.4 mm of rainfall was recorded in the bureau's main station.

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
June 12, 2020	June 14, 2020	Nuri	No. 3
Jul 31, 2020	Aug 02, 2020	Sinlaku	No. 3
Aug 17, 2020	Aug 19, 2020	Higos	No. 10
Oct 11, 2020	Oct 14, 2020	Nangka	No. 8
Oct 22, 2020	Oct 24, 2020	Saudel	No. 3

2. Hydrological Assessment

Nil.

3. Socio-Economic Assessment

Macao was hit by five tropical cyclones in 2020. Typhoon "Higos" was the strongest typhoon which required the issuance of typhoon signal no.10. Typhoon "Higos" caused 15 people injured, 9 trees fallen, 66 Concrete spalled off and 111 billboards collapsed, etc.

Typhoon "Nangka" required the issuance of typhoon signal no. 8, which didn't cause a big damage to Macao. As a result, 1 person was injured, 2 trees fallen and 6 billboards collapsed. There were fewer incidents occurred in other typhoons this year. For more information, please refer to table 2.

In the last two years, there were around 5 to 6 tropical cyclones hitting Macao, and only 1 to 2 tropical cyclones could hoist typhoon signal no 8 and 10. Comparing with the incidents, the damage to Macao was not so serious in 2020, due to the fact that Macao SAR government has put much effort and has implemented effective measures, as well as Macao citizens have better preparation for the coming of the typhoon.

Seven rainstorm warnings were issued in 2020. Table 3 showed that besides flooding occurred in low lying areas, the rainstorm didn't cause severe damages to Macao. A few cases of fallen trees, landslide and windows collapsed were happened. Table 3 showed that the most serious threat to Macao was flooding. Once there is

heavy rainfall, flooding occurs in low lying areas. In recent years, the Macao SAR government has taken many measures to solve this problem. Although flooding still occurs, the damage caused has been reduced year by year.

Table 2 *Damages caused by tropical cyclones in Macao in 2020.*

Date/Time		Name	The Highest Signal Hoisted	Incidents (cases)									
Start	End			Flooding	Landslide	Fallen Trees	Buildings collapsed/ Concrete spalled off	Billboards/ Awnings/ Windows/ (Collapsed/ Tottered)	Scaffoldings / Fencings/ Crane (Collapsed/ Tottered)	Power cables/ Lamppost s (Collapsed/ Tottered)	Injuries	Death	Others
12-06-2019H00	14-06-2013H00	Nuri (2002)	3	0	0	0	0	0	0	0	0	0	0
31-07-2020H00	02-08-2002H00	Sinlaku (2003)	3	0	0	0	0	1	0	0	0	0	0
17-08-2020H00	19-08-2015H30	Higos (2007)	10	4	1	9	66	111	15	10	15	0	33
11-10-2022H00	14-10-2005H00	Nangka (2016)	8	0	0	2	0	6	1	0	1	0	3
22-10-2018H00	24-10-2011H00	Saudel (2017)	3	0	0	0	0	0	0	0	0	0	0

Table 3 *Damages caused by rainstorms during 2020.*

Date/Time		Incidents (cases)									
Start	End	Flooding	Fallen Trees	Buildings collapsed/ Concrete spalled off	Billboards collapsed or tottered	Scaffoldings collapsed or tottered	Windows collapsed or tottered	Awnings collapsed or tottered	Landslide	Injuries	Others
21-05-2020 01H20	21-05-2020 05H00	4	0	1	0	0	0	0	0	0	1
25-05-2020	25-05-2020	13	1	1	0	0	0	0	1	0	1

10H40	13H35										
30-05-2020 05H50	30-05-2020 15H30	30	1	0	0	0	1	0	2	5	15
06-06-2020 03H55	06-06-2020 09H00	1	0	0	0	0	0	0	0	0	0
08-06-2020 05H35	08-06-2020 07H30	13	0	0	0	0	0	0	0	0	0
05-08-2020 09H35	05-08-2020 11H00	1	0	0	0	0	0	0	0	0	0
08-09-2020 07H20	08-09-2020 09H15	0	0	0	0	0	0	0	0	0	0

II. Summary of Progress in Priorities supporting Key Result Areas

1. Effective of the Executive Orders related to the "New Rainstorm Warning Signal System"

Main text:

The Executive Order related to the "New Rainstorm Warning Signal System" was effective since 1 Sept 2020. The "New Rainstorm Warning Signal System" is divided into 3 levels to reflect the risk and impact brought by rainstorms of different intensities, allowing different social stakeholders to take appropriate contingency measures according to their own conditions and needs. In addition, the new executive order also improves the safety alert of the "Thunderstorm Warning Signal". To enhance the public's understanding of the "New Rainstorm Warning Signal System", works on the publicity has been ongoing,

Figure 2&3 *Poster of the New Rainstorm Warning System. (top)*
Seminar on the New Rainstorm Warning System. (bottom)

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.

Contact Information:
Member: Macao, China
Name of contact for this item: Ms. Sau Wa CHANG
Telephone: +853 8898 6180
Email: swchang@smg.gov.mo

2. Enhanced public weather service

Main text:

The new website and mobile APP (android and IOS version) of SMG were officially launched on 23 March 2020. 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 and warnings, or even precautions to weather phenomenon can be sent at ease.

Moreover, in response to more frequent natural disaster and the potential occurrence of extreme weather events, SMG continued to improve the effectiveness of the release of weather warning and information. A new Telegram channel was also officially launched on 23 March 2020.

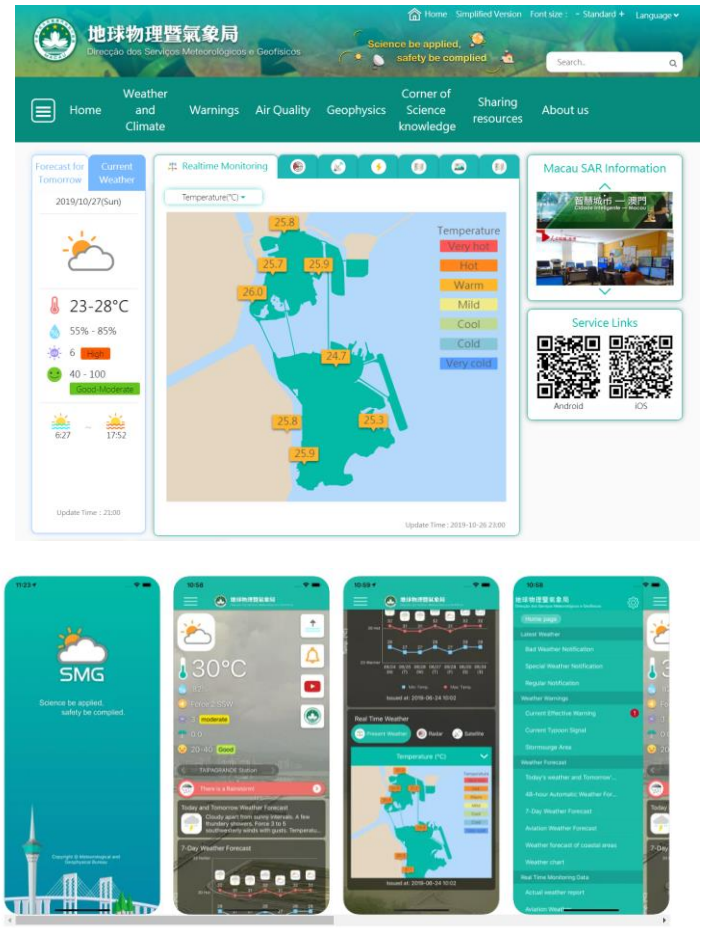

Figure 4&5 *New SMG website and mobile APP, officially launched in March 2020.*

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.

Contact Information:

Member: Macao, China
Name of contact for this item: Ms. Sau Wa CHANG
Telephone: +853 8898 6180
Email: swchang@smg.gov.mo

3. **Promotion of 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 precautionary measures should be taken against different severe weather phenomenon. Meanwhile, SMG also cooperates with Macao Science Center in the production of a series of short films concerning weather forecasting, especial those about tropical cyclones.

In addition, SMG and the Macao Science Center worked together to organize series of activities and competitions to promote knowledge about meteorology, DRR(Disaster Risk Reduction) and STEM education concept. There were activities such as dramas introducing the typhoon and storm surge warnings to young children, giving lectures to let young children to learn and try to act as a weather forecaster, and a competition was held about weather monitoring by setting-up weather stations in schools using the SparkFun weather:bit with extra sensors, associated with the use of the BBC micro:bit board.

Figure 6 &7 *Dramas introducing different warnings and lectures to become a weather forecaster for young children.*

Figure 8 *A weather station setup in school using micro:bit.*

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.

Contact Information:

Member: Macao, China

Name of contact for this item: Mrs. Sau Wa CHANG

Telephone: +853 8898 6130
Email: swchang@smg.gov.mo

4. Personnel capacity-building

Main text:

In order to promote the ability of the meteorological staffs, SMG staffs participated in different on-job training, workshops and seminars which included:

i. on-job training at nearby region;
ii. joining workshops and seminars, such as TC Roving Seminar, IWS etc.

Figure 9 *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.

Contact Information:

Member: Macao, China
Name of contact for this item: Mr. Ieng Wai LAO
Telephone: +853 8898 6200

Email: allanlao@smg.gov.mo

5. Hardware capacity-building

Main text:

New AWSs and water level monitoring stations were constructed to enhance the monitoring of meteorological element and flooding over Macao. Besides, in order to further strengthen the monitoring and early warning capabilities of severe weather, the meteorological authorities of Zhuhai and Macao signed the "Zhuhai-Macao Phased Array Weather Radar Project Cooperation Agreement", which related to the construction of a network of 4 X-band phase array weather radars to form a “Phased array radar network”. The X-band phased array weather radar are able to perform more precise and faster monitoring. Through collaborative observation with the existing Zhuhai-Macao weather radar, it can effectively monitor the development of short-term severe weather such as rainstorm, hail, and tornado in the vicinity of Macau.

In order to improve the meteorological disaster prevention and mitigation capabilities of the two cities, the meteorological authorities of the two cities signed the "Zhuhai-Macao Meteorological Resource Sharing Cooperation Plan" in 2009 to strengthen the sharing of meteorological data, joint prevention of meteorological disasters, co-construction and sharing of weather monitoring. In recent years, we have cooperated in the establishment of the "Pearl River Estuary Comprehensive Meteorological Observation Network", introducing new types of weather monitoring equipment such as radar, microwave radiometer and wind profiler radar to jointly enhance the comprehensive weather observation capabilities of Macao and the west bank of the Pearl River Estuary.

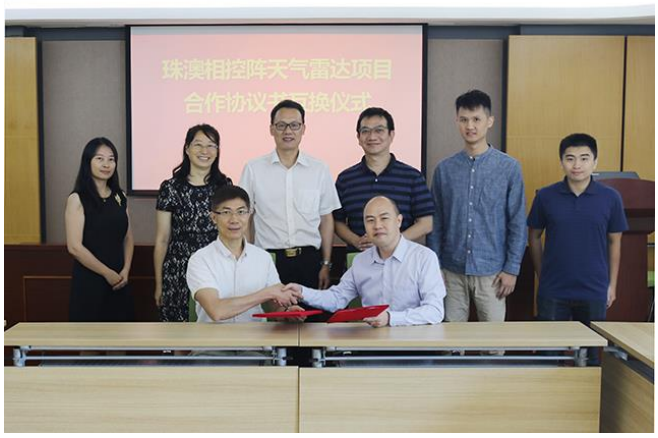

Figure 10 *Signing of the* "Zhuhai-Macao Phased Array Weather Radar Project Cooperation Agreement"

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.

Contact Information:
Member: Macao, China
Name of contact for this item: Mr. Ieng Wai LAO
Telephone: +853 8898 6200
Email: allanlao@smg.gov.mo

6. **Improving operational system for tropical cyclone forecast:**

Main text:

SMG is developing an integrated analysis system for tropical cyclone and storm surge (TSIAS), which can 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 analyze all useful information easily.

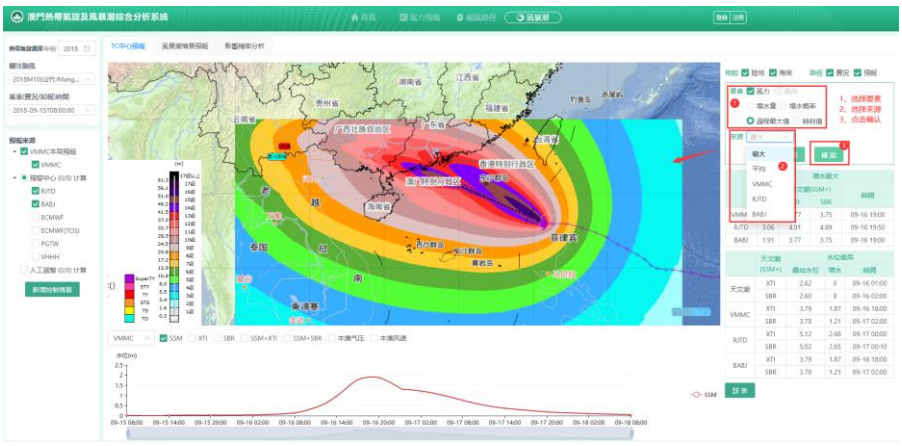

Figure 11 *Screenshot on the TSIAS system.*

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.

Contact Information:

Member: Macao, China
Name of contact for this item: Mr. Vai Kei IAN
Telephone: +853 8898 6260
Email: brianian@smg.gov.mo

7. **Public Education and Promotion among communities and schools to enhance emergency response capabilities and self-protection awareness**

Main text:

In order to enhance the emergency response capabilities and the self-protection awareness of Macao citizens in emergency situation, Unitary Police Service committed to strengthen the education and sharing information of disaster prevention among communities and schools.

Every year before typhoon season, Unitary Police Service will keep on promoting and educating the public in different low lying areas in Macao, such as holding seminars, drills and distributing leaflets about the “Storm Surge Evacuation Plan in Low-lying Areas During Typhoon” and the “Sound Siren in High Ground and Low-lying Areas For Storm Surge”, explaining the contents and precautions of the evacuation plan and introducing the audio alarm system. This aims to strengthen the emergency awareness and self-rescue ability of the public, improve their awareness of emergency and remind them to prepare food storage, emergency information etc. before the typhoon season. Unitary Police Service hopes to work together with the citizens to minimize the impact and losses caused by typhoon.

On the other hand, Education and Youth Bureau, with the assistant of Unitary Police Service, prepared the “Disaster Prevention Plan for School”, “Disaster Prevention Guidelines for School” and “Safety Education Supplementary Teaching Materials”. The relevant teaching materials will be included in their syllabus, which aims to develop students’ disaster prevention knowledge and skills from an early age and hope to spread the knowledge of civil protection among their families.
Unitary Police Service and Education and Youth Bureau also cooperate with Macao Customs Service, Public Security Police Force, Judicial Police and Fire Services Bureau, to carry out jointed disaster prevention education project for 77 primary and secondary schools in Macao, with the purpose of strengthening the students’ knowledge of “Storm Surge Evacuation Plan in Low-lying Areas During Typhoon”. Also, drills related to typhoon prevention, fire prevention and flood prevention are conducted among all primary and secondary schools in Macao. After the drills, conclusion will be made and opinions and advices will be provided.

In order to enhance students’ knowledge of civil protection and the civil protection publicity and education, Unitary Police Service and Education and Youth Bureau organize students to visit the Civil Protection Operation Center and will explain the details of the civil protection law, the concept and system of the civil protection, as well as the classification of public emergencies, etc.

In addition, due to the COVID-19, guidelines of Health Bureau have been strictly complied. No matter arrangement of students’ visits or public education activities, body temperature will be monitored and hand sanitizer will be provided and everyone will be wearing masks.

8. **Renewal of the Civil Protection Law**

Main text:

Macao SAR Government had announced law about civil protection which improves different aspects of civil protection, it strengthens the legal support as for better management system and operation mechanism, promote society to improve the awareness and ability of disaster prevention and self-rescue, and the synergy of government, society and residents for better prevention of response to emergency situation. Civil protection will be developed in education to the public about preparation, emergency response and aftermath recovery.

Unitary Police Service will cooperate with security forces and security departments explain the content of the law to the residents, so as to strengthen the public's awareness, their understandings of civil protection system and obligations and responsibilities. This will help to have better cooperation between the different civil protection departments and the residents to achieve better results in preventing and responding to various emergencies situation.

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.

Contact Information:

Member: Macao, China
Name of contact for this item: Mr. Su Hon Ho
Telephone: +853 6686 0810
Email: copc@fsm.gov.mo

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

Main text:

Civil Defense drill in 2020

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 2020 annual meeting was held on 15th May, during the meeting, the representative of the Unitary Police Service introduced the details of the annual drill 2020 and announced the date of the drill to the public. Besides, the representative of the Meteorological and Geophysical Bureau made the meteorological review in 2019 and weather forecast in 2020; 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 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 last few years, 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.12). Through the participating of the public, hope to increase the public awareness of risk prevention and enhance their self-rescue ability.

Figure 12 *Evacuation exercise during annal drill "Crystal Fish 2020".*

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.

Contact Information:
Member: Macao, China
Name of contact for this item: Mr. Su Hon Ho
Telephone: +853 6686 0810
Email: copc@fsm.gov.mo