

**MEMBER  
REPORT  
Macao, China**

ESCAP/WMO Typhoon Committee  
16<sup>th</sup> Integrated Workshop  
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# I. Overview of tropical cyclones which have affected/impacted Member's area since the last Committee Session

## 1. Meteorological Assessment (highlighting forecasting issues/impacts)

7 tropical cyclones affected Macao, China in 2021, including tropical storm Koguma (2104), typhoon Cempaka (2107), tropical storm Lupit (2109), severe tropical storm Conson (2113), tropical storm Lionrock (2117), typhoon Kompasu (2118) and one tropical depression (no name). Their tracks and the highest issued Tropical Cyclone Signals in Macao are shown in fig. 1 and table 1 respectively. Their meteorological influences on Macao are described below in details.



Figure 1 Tropical cyclone tracks that affected Macao, China in 2021.

### Tropical Storm Koguma (2104)

Koguma was developed in June and was the first tropical cyclone affected Macao in 2021. It was formed in the South China Sea and moved northwestwards towards Hainan Island and Vietnam. It came closest to Macao on the June 11<sup>th</sup> night, about 450km to the west-southwest of Macao.

Since the convection mainly developed in the southern quadrant of Koguma, its impact on Macao was minimal. Fresh breezes blew in Macao for most of the time, yet near gale force wind was once recorded temporarily while the related rainbands of Koguma were affecting Macao.

### **Tropical Depression “Nameless”**

There was a large cyclonic circulation over the South China Sea at the beginning of July. Two tropical depressions were formed within the circulation, where one over the South China Sea and one over the seas east to the Philippines. Since the latter one dissipated after it passed the Luzon Strait, it did not affect Macao at all. On the other hand, the one over the South China Sea moved northwards at first. Tropical cyclone signal no.1 was issued as long as it was approaching the south China coast. However, it then turned in the direction of west-northwest towards Hainan Island and it finally came closest to Macao about 530km. As it was far away from Macao and it was just a tropical depression, its impact on Macao was minimal.

### **Typhoon Cempaka (2107)**

A low-pressure area was developed on July 15<sup>th</sup> in the northern part of the South China Sea. It experienced a rapid intensification near the south China coast, from a tropical depression to a typhoon between 18<sup>th</sup> and 20<sup>th</sup>. However, it also weakened quickly after it had made landfall at Yangjiang on 20<sup>th</sup>. It then moved in a counterclockwise direction through Guangdong and Guangxi and entered the Beibu Gulf on 23<sup>rd</sup>. It finally dissipated there on the 24<sup>th</sup> night.

Cempaka came closest to Macao in the evening on 19<sup>th</sup>, around 120km southwest to Macao. Though Cempaka was very close to Macao, it did not cause a severe impact as its circulation was small, whose 30kt wind radius was just about 100km. During the period of issuing tropical cyclone signals, 130mm accumulated rainfall amount was recorded and the maximum 10min average windspeed reached force 7.

### **Tropical Storm Lupit (2109)**

A broad low-pressure trough covered southeast China at the beginning of August and there were several tropical depressions within the trough. One of them was developed near the coast east of the Leizhou Peninsula on Aug 2<sup>nd</sup>. Under the influence of large-scale counterclockwise circulation, the moving path of Lupit was different from the usual. It moved eastwards along with the coast of southeast China and entered the East China Sea through the Taiwan Strait.

Lupit came very close to Macao, but luckily it was still a tropical depression when it came within 100km of Macao. Since it was lack of organization and its convection mainly developed in the southern quadrant then, its impact on the Pearl River Delta was minimal. There were just a few showers and strong winds in Macao.

### **Severe Tropical Storm Conson (2113)**

Conson was developed over the seas east to the Philippines on Sep 6<sup>th</sup>. It kept intensifying and entered the South China Sea as a severe tropical storm. It moved westwards steadily across the middle part of the South China Sea and dissipated near the coast of Vietnam on 12<sup>th</sup>. Meanwhile, another tropical cyclone Chanthu was developed over the northwest Pacific and became a super typhoon. Since there were two tropical cyclones in the same area, their forecast tracks were full of uncertainties during that time under their influences of each other. As a result, considering the risk that one of the tropical cyclones might affect the coast of Guangdong, the tropical cyclone signal no.1 was issued when Conson entered the 800km alert radius of Macao.

Since both Conson and Chanthu kept distances away from Macao at last, it turned out to be very hot in Macao under the influence of the subsidence airstreams.

### **Tropical Storm Lionrock (2117)**

Lionrock was developed in the middle part of the South China Sea at the beginning of October. It moved northwards at first towards Hainan Island. While it was approaching Hainan, it came closest to Macao, around 450km southwest of Macao. After Lionrock passed the Hainan island, it turned northwestwards and entered the Beibu Gulf. It finally weakened into a depression near the coast of Vietnam.

At the same time, a cold high system was affecting China. Under the accompanied effect of its related northeast monsoon and Lionrock’s circulation, winds over the south China coast were up to force 6 and even gale-force winds were recorded in Macao. As a result, the first tropical cyclone signal no.8 this year was issued and became the farthest tropical cyclone which caused signal no.8 in the record. Furthermore, the confluence of Lionrock’s circulation and the subtropical high ridge induced a persistent rainband over the Peral River Delta. Heavy showers lasted for hours in Macao and caused floodings. Over 200mm daily accumulated rainfall amount was recorded, which had become the maximum daily precipitation in October since 1952.

### **Typhoon Kompasu (2118)**

Kompasu was first developed over the seas east to the Philippines. It intensified into a typhoon progressively and moved westwards steadily. It entered the South China Sea on Oct 12th and landed the Hainan island on 13th. Afterward, it started to weaken and moved to the Beibu Gulf. It finally dissipated there.

Alike the situation of Lionrock, the south China coast was also influenced by the accompanied effect of the circulation of Kompas and the northeast monsoon. Windspeed up to force 8 was recorded in Macao with a maximum gust of 94km/hr. Kompasu also induced a significant storm surge in Macao. Flooding occurred in low-lying areas, about 0.43m high. The blue storm surge warning was issued.

<b>Start Date</b>	<b>End Date</b>	<b>Name</b>	<b>The Highest Signal</b>
Jun 11, 2021	Jun 12, 2021	Koguma	No. 1
Jul 6, 2021	Jul 7, 2021	Tropical Depression	No. 1
Jul 18, 2021	Jul 21, 2021	Cempaka	No. 3
Aug 2, 2021	Aug 4, 2021	Lupit	No. 3
Sep 9, 2021	Sep 10, 2021	Conson	No. 1
Oct 7, 2021	Oct 10, 2021	Lionrock	No. 8
Oct 11, 2021	Oct 14 2021	Kompasu	No. 8

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

## **2. Hydrological Assessment (highlighting water-related issues/impact)**

Nil.

### 3. Socio-Economic Assessment (highlighting socio-economic and DRR issues/impacts)

Macao was hit by seven tropical cyclones in 2021. Typhoon Lionrock which hoisted typhoon signal no.8, has caused 6 people injured, 2 flooding, 1 tree fallen, 1 concrete spalled off, 4 Scaffoldings collapsed and 18 billboards collapsed, etc.

Typhoon Kompasu also hoisted signal no. 8, which didn't cause a big damage to Macao. As a result, 1 flooding, 1 concrete spalled off, 5 billboards collapsed and 1 person injured. However, there were fewer incidents occurred in other typhoons this year. For more information, please refer to table 2.

In the past year, there were five tropical cyclones hitting Macao, and only 2 of them could hoist typhoon signal no 8 or above. Comparing with the incidents, the damage to Macao was not so serious in 2021, due to the fact 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.

Due to the COVID-19, preventions of the two typhoons mentioned above have also adopted various sanitation and epidemic prevention measures. For example, the temporary shelters strictly follow the guidelines of Health Bureau, strengthen the sanitation measures and keep social distance.

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/ Lampposts (Collapsed/ Tottered)	Injuries	Death	Others	
11/6/2021 16H30	12/6/2021 18H00	Koguma 2104	1	0	0	0	0	0	0	0	0	0	0	1
18/7/2021 17H00	21/7/2021 01H00	Cempaka 2107	3	0	0	1	0	0	0	0	0	0	0	1
02/08/2021 19H00	4/8/2021 17H00	Lupit 2109	3	0	0	0	0	0	0	0	0	0	0	0
9/9/2021 18H00	10/09/2021 21H00	Conson 2113	1	0	0	0	0	0	0	0	0	0	0	0
07/10/2021 19H00	10/10/2021 17H00	Lionrock 2117	8	2	0	1	1	18	4	0	6	0	4	
11/10/2021 20H00	14/10/2021 07H00	Kompasu 2118	8	1	0	0	1	5	0	0	1	0	2	

**Table 2** Damages caused by named tropical cyclones in Macao in 2021

Sixteen rainstorm warnings were issued in 2021. From table 3, we can see that there were 9 rainstorms more in 2021 comparing with 2020, and the rainstorm on 1<sup>st</sup> June, 2021 was the most serious, resulting 29 cases of flooding in low lying areas and 6 people injured. Actually, the common incidents that happened in Macao were usually flooding and landslide. Once there is heavy rainfall, flooding occurs in low lying areas, and sometimes landslide occurs. In recent years, the Macao SAR government has taken flood control and drainage measures to solve the problem. For example, installing flood gate, constructing flood wall and rain water pumping station, educating citizens about actions take when rainstorm occurs, so as to minimize the damage.

<b>Incidents (cases)</b>											
<b>Start</b>	<b>End</b>	<b>Flood- ing</b>	<b>Fallen Trees</b>	<b>Buildings collapsed/ Concrete spalled off</b>	<b>Billboards collapsed or tottered</b>	<b>Scaffoldings collapsed or tottered</b>	<b>Windows collapsed or tottered</b>	<b>Awnings collapsed or tottered</b>	<b>Landslide</b>	<b>Injuries</b>	<b>Others</b>
01-06-2021 05H00	01-06-2021 07H00	29	0	1	0	0	0	0	0	6	0
01-06-2021 07H00	01-06-2021 08H00	0	0	0	0	0	0	0	0	0	2
01-06-2021 14H40	01-06-2021 18H20	15	0	0	1	0	0	0	1	3	0
01-06-2021 21H15	01-06-2021 22H45	1	0	1	0	0	0	0	0	1	0
22-06-2021 07H50	22-06-2021 09H20	1	4	0	0	1	1	0	0	0	2
23-06-2021 07H10	23-06-2021 09H35	1	0	0	0	0	0	0	0	0	3
28-06-2021 04H40	28-06-2021 04H50	1	0	0	0	0	0	0	0	0	2
28-06-2021 04H50	28-06-2021 06H00	2	0	0	0	0	0	0	0	0	0
28-06-2021 06H00	28-06-2021 06H25	0	0	0	0	0	0	0	0	0	0
24-07-2021 14H50	24-07-2021 15H35	0	0	0	0	0	0	0	0	0	0
01-08-2021 13H35	01-08-2021 14H00	0	0	0	0	0	0	0	0	0	0
01-08-2021 14H00	01-08-2021 15H00	2	0	0	0	0	0	0	0	0	0
01-08-2021 15H00	01-08-2021 15H30	0	0	0	0	0	0	0	0	0	1
08-10-2021 09H35	08-10-2021 11H00	1	0	0	0	0	0	0	0	0	0
10-10-2021 05H40	10-10-2021 07H00	0	0	0	0	0	0	0	0	1	1
10-10-2021 08H05	10-10-2021 15H05	4	1	3	0	0	0	1	12	0	2

*Table 3 Damages caused by rainstorms in 2021*

#### 4. Regional Cooperation (highlighting regional cooperation and related activities)

Nil.

## II. Summary of Progress in Priorities supporting Key Result Areas

### 1. Enhanced public weather service

#### Main text:

The region of coverage for typhoon track images of tropical cyclones has been enriched, in replacement for the existing ones. This allows citizens to have a better insight of the possible affecting areas for the corresponding tropical cyclones, either affecting us directly, indirectly or do not have any influence to us at all. In addition, forecast time resolution for individual tropical cyclone has been extended to 120 hours, in accordance with the threats posed by specific tropical cyclone, such that the public can take the corresponding course of precaution whenever necessary. Furthermore, SMG continued to enhance the provision weather warning messages and information in a timely and informative manner through various communication channels; and to ensure effectiveness of issued messages could be delivered without any delay or doubts, in response to the frequent and intense natural disasters and potential occurrence of any extreme weather events.

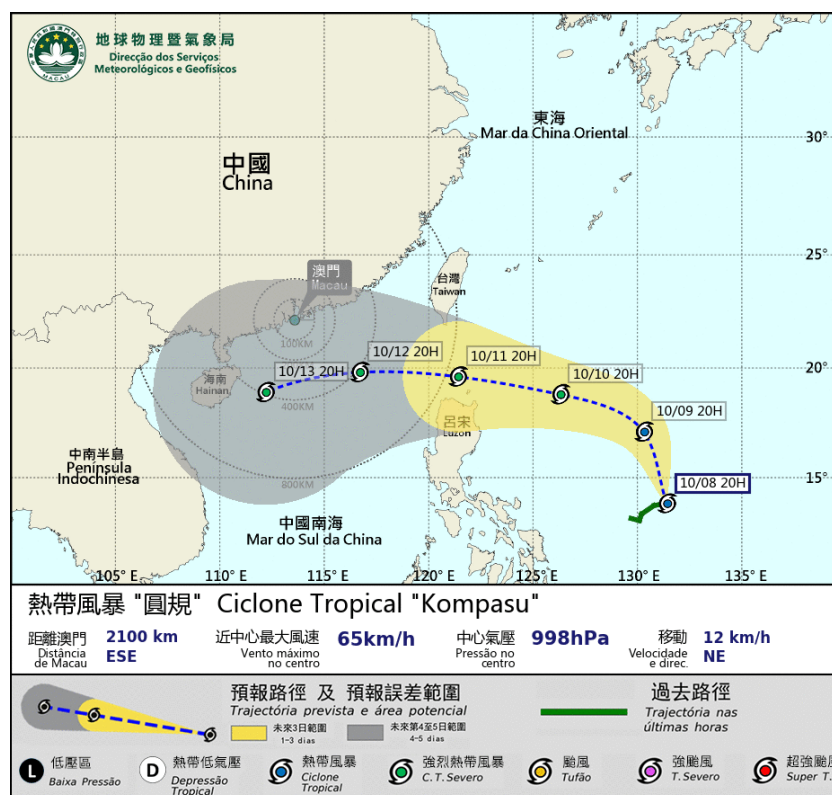


Figure 2 Expand coverage region for typhoon track.



Effective approaches in message delivery, apart from the quality of the enhanced features from the issuance of pre-warning message itself, include the strengthening of the communication and coordination with relevant departments, media, and the public. This applies to any severe weather occasion, especially the attacks from tropical cyclones. Through the organization of different video conference meetings with various related parties in the discussion of the trends and impacts for tropical cyclones and possible damages that could be taken place allows us to share relevant information and forecasts among each other. Nevertheless, products related to extreme weather and tropical cyclones have also been enhanced such that more detailed information could be delivered to the public and allows them to better understand and well prepared in advance for the influences brought by the current extreme weather situation. For instance, a new product with lightning overlapped with radar images, has been scheduled to be released this year, facilitating the citizens to clearly identify the location of lightning and understand the distribution and relationship of lightning in the location of the rain area, and further information could be grasped. To move one step ahead, we have a thorough discussion with the media and an upgraded version for the dedicated website for the media is about to be launched such that they can have an immediate and express access to the current weather phenomena, especially warnings and precautions.

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

Nil.

**Priority Areas Addressed:**

Meteorology

- Enhance the capacity to monitor and forecast typhoon activities particularly in genesis, intensity and structure change.
- Enhance and provide typhoon forecast guidance based on NWP including ensembles and weather radar related products, such as QPE/QPF.

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## **2. Improving operational system for tropical cyclone forecast**

**Main text:**

SMG is building a storm surge forecast model which collects warnings and forecasts from various sources and features from tropical cyclones in making estimations for possible occurrences of storm surges. This system is equipped with a “what-if” scenario to better accommodate different resulting impacts that would take place if changes occurred in the movement or intensity of the targeted tropical cyclone.

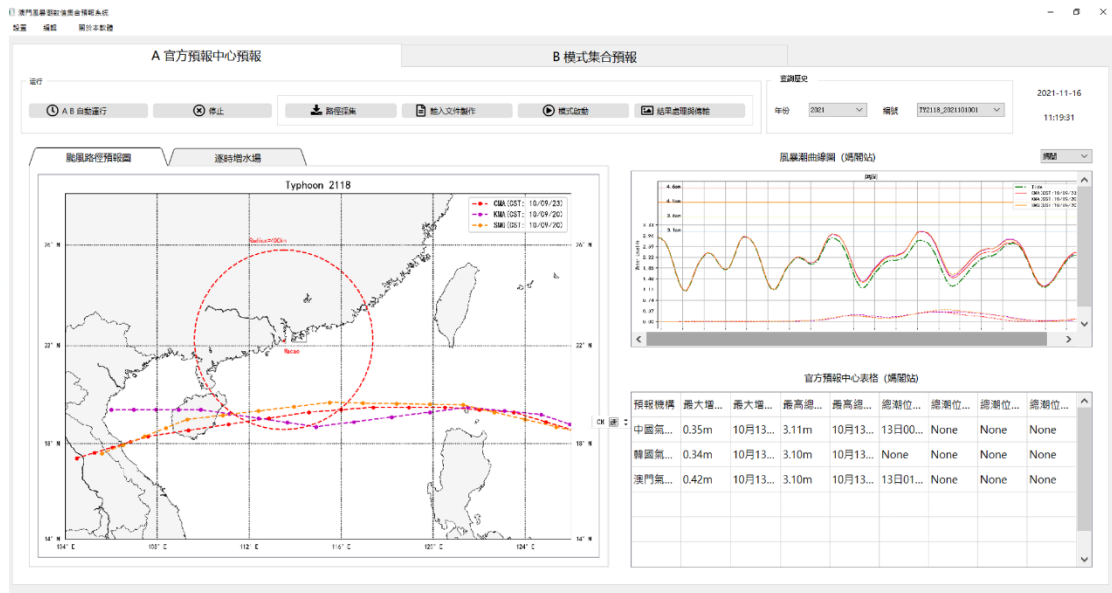


Figure 3 Screenshot on the storm surge forecast system – warning mode

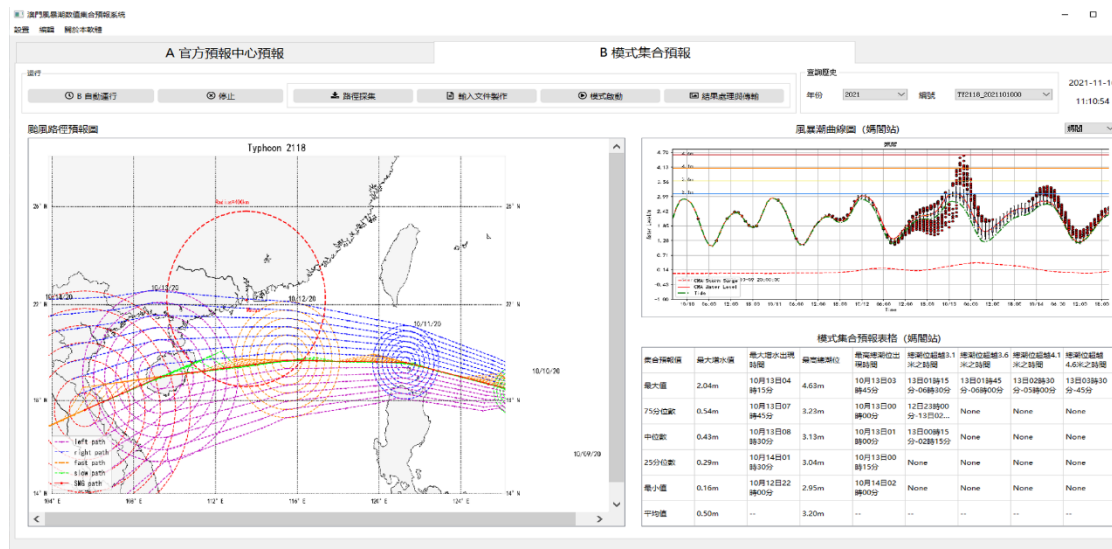


Figure 4 Screenshot on the storm surge forecast system – ensemble mode

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

**Priority Areas Addressed:**

Meteorology

- Develop and enhance typhoon analysis and forecast technique form short- to long-term.

Hydrology

- 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.
- Enhance capacity in impact-based and community-based operational flood forecasting and early warning, including methodology research, hydrological modelling, and operation system development.



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

Nil

**Priority Areas Addressed:**

Meteorology

- Develop and enhance typhoon analysis and forecast technique from short- to long-term.
- Enhance and provide typhoon forecast guidance based on NWP including ensembles and weather radar related products, such as QPE/QPF.

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#### **4. Contingency plan for 24-7 operation**

**Main Text:**

Due to COVID-19, the Macao SAR takes proper precautions such as quarantine or individual area lockdown to prevent the virus outbreak in the society. In order to keep our weather services all of the time, we made contingency plans. We set up two backup offices in case any of our staff caught COVID-19, or our forecast center was ordered to lockdown. All equipment is well-prepared there and all kinds of weather reports and severe weather warnings including tropical cyclone signals are able to be published. Drills were also implemented for testing the offices were well-prepared.

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

Nil

**Priority Areas Addressed:**

DRR

- Enhance Members' disaster reduction techniques and management strategies.

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## 5. Promotion of the knowledge of meteorology and disaster risk reduction

### Main Text:

In order to educate the public with knowledge of meteorology and disaster risk reduction, SMG produced videos, audio and print advertisements about severe weather, and they are released on television, radio, bus TV, newspapers, mobile apps, and government websites to maximize effectiveness.

In addition, SMG organized various promotional activities. Trainings were held for community emergency volunteers to enhance their effectiveness of assisting in disaster prevention and mitigation. SMG organized family fun activities, in which parents and children learned about severe weather through visit to the SMG, first-hand experience as a forecaster, and watching stage plays. Visits to the Bureau from schools and other groups are also organized. SMG participated in the civil protection knowledge promotion activities coordinated by Unitary Police Service to explain typhoon and storm surge knowledge to various communities and residents in order to enhance public awareness.



*Figure 6 SMG actively promotes knowledge of meteorology and natural disasters, and scientific understanding of disaster prevention*

On the other hand, SMG and the Macao Science Center co-organized activities including 30 “weather theaters”, summer activity classes, and "Campus Weather Monitoring Competition" to promote meteorology knowledge to students of different age groups in a variety of ways.

In order to enhance the knowledge in meteorology and disaster risk reduction for public and private institutions, SMG invited the principals and management staff of all schools in Macao to participate in the "Severe Weather Response Exchange Meeting". In addition, SMG invited the leaders and management personnel of members of the Civil Protection system to participate in the "Tropical Cyclone and Storm Surge Exchange Meeting" to strengthen the members' knowledge and understanding of tropical cyclone and storm surge, so as to enhance the efficiency of the work in disaster prevention and mitigation in their respective areas.



**Figure 7** SMG and the Macao Science Center co-organized weather stage plays, promoting knowledge of meteorology and natural disasters.



**Figure 8** Nearly 100 teachers and students participated in the "Campus Weather Monitoring Competition" co-organized by SMG and the Macao Science Center.



**Figure 9** SMG invited the principals and management staff of all schools in Macao to participate in the "Severe Weather Response Exchange Meeting".



**Figure 10** SMG invited the leaders and management personnel of members of the Civil Protection system to participate in the "Tropical Cyclone and Storm Surge Exchange Meeting".

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

Nil.

**Priority Areas Addressed:**

Meteorology

- Strengthen the cooperation with WGH and WGD RR to develop impact-based forecast and risk-based warning.

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## 6. Drill with Government Departments and Organizations

### **Main text:**

In response to the typhoon season in Macao, the Unitary Police Service holds one civil protection drill every year. “Crystal Fish 2021”, the drill for this year, was held on 24 April 2021 with participation from all members of the civil protection structure.

The 4.5-hour drill simulated about 60 accidents that might happen during a typhoon. There were some 2,700 participants, involving 17 non-governmental organisations and 371 citizens.

The drill also covered the “Low-Lying Areas Evacuation Plan for Storm Surge during Typhoon”. It aimed to strengthen communication and coordination among members of the civil protection structure and review the efficiency of the emergency plans by various departments. The exercise also familiarised citizens with evacuation procedures and routes.

This year, a new system “Low-Lying Areas Screening and Evacuation System” was added to facilitate the work of those responsible entities for evacuation, and enable the Civil Protection Operations Centre to monitor the entire evacuation process.

The system was tested during the drill to find faults in the procedures, technologies and responses. Improvements were made in all regards to maximise its capacity to safeguard and protect the life and property of citizens in this ever-changing environment.

In addition, to cope with COVID-19, the Macao Government held a drill to simulate its zone-specific, multi-level approach to epidemic prevention and control, and a tabletop exercise to review the preparedness of the civil protection system.

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

Nil.

### **Priority Areas Addressed:**

#### DRR

- Enhance Members’ disaster reduction techniques and management strategies.
- Evaluate socio-economic benefits of disaster risk reduction for typhoon-related disasters.

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## **7. In the state of immediate prevention, Macao was hit by two tropical storms amid “zone-specific, multi-level approach to epidemic prevention and control”**

### **Main text:**

Due to COVID-19, the Chief Executive of Macao SAR declared to enter the state of immediate prevention as from 00:00 on 25 September 2021, activating civil protection structure at the same time. The Civil Protection Operations Centre operated round the clock to support the anti-pandemic efforts of the Novel Coronavirus Response and Coordination Centre.

In the state of immediate prevention, Macao was further affected by tropical storm Lionrock and severe tropical storm Kompas, hoisting Tropical Cyclone Signal No.8 (T8) from 06:00 on 9 October to 02:00 on 10 October and from 22:30 on 12 October to 17:30 on 13 October respectively.

In short, the state of immediate prevention lasted from 00:00 on 25 September to 12:00 on 15 October 2021, during which Macao hoisted T8 twice. The Civil Protection Operations Centre not only had to assist the Novel Coronavirus Response and Coordination Centre, but also had to cope with the impacts of the tropical storms. This will be a good experience to draw on in case that public emergencies might happen at the same time.

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

Nil.

### **Priority Areas Addressed:**

#### DRR

- Enhance Members’ disaster reduction techniques and management strategies.

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