

Storm Surge Warning Services in Macao

Macao, China

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Content

1 Background

2 Storm Surge Warning in Macao

3 Early warnings for all (EW4All)

4 EW4ALL Pillar 2

5 EW4ALL Pillar 3

6 EW4ALL Pillar 4

7 EW4ALL Pillar 1

Background

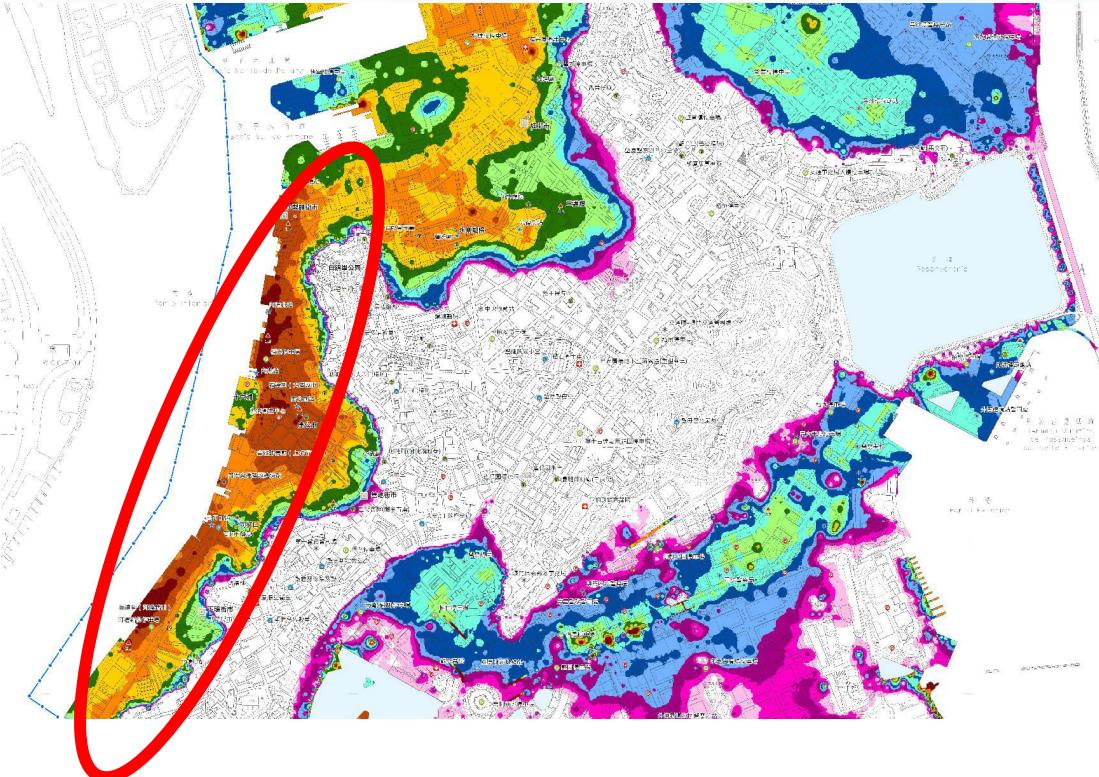


Centuries ago, Macao was an **important port** on the southern coast of China.

At that time, the inner harbor was built close to sea level **to ease goods handling** for workers.

Background

As a result, **inner harbor** is Macao's lowest-lying district



Background

Storm Surge Warning



In **September 2008**, Macao was affected by typhoon “**Hagupit**”, many low-lying areas were severely impacted by storm surge. Therefore, Macao established the **first version** of the storm surge warning.

Background

Storm Surge Warning



Storm Surge Warning

According to the geographic features, historical record of water level and meteorological characteristic of the Macao Special Administrative Region, "Storm Surge" warnings are divided into following five levels:

	First Level Warning / Blue	The water level is expected to be below 0.5 meter above road level.
	Second Level Warning / Yellow	The water level is expected to be 0.5 to 1.0 meter above road level.
	Third Level Warning / Orange	The water level is expected to be 1.0 to 1.5 meter above road level.
	Fourth Level Warning / Red	The water level is expected to be 1.5 to 2.5 meter above road level.
	Fifth Level Warning / Black	The water level is expected to be above 2.5 meter from road level.

All the figures in the above table are based on the road level of Porto Interior.

After typhoon "Hato" in 2017, we renewed the storm surge warning signal to a **second version** in 2018. There are **five levels** in total, all based on the elevation of the inner harbor roads.

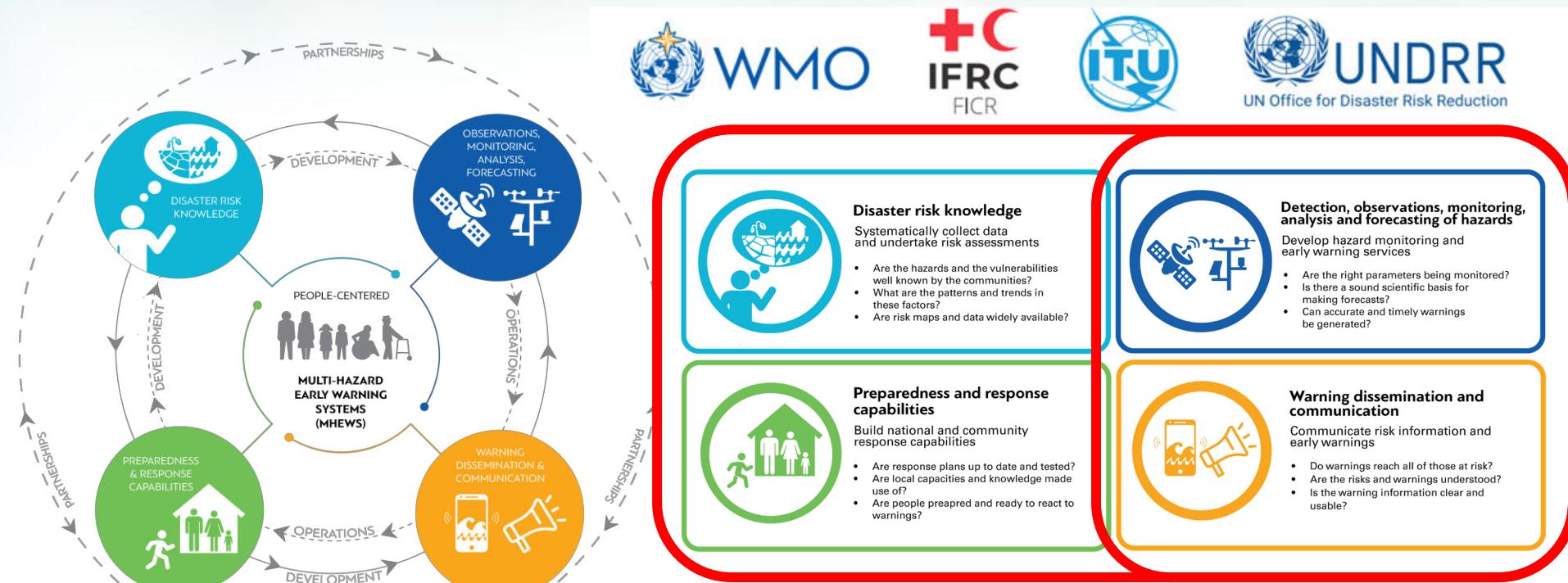
Background

Super TY “RAGASA”



This year, Macao was hit by super typhoon “Ragasa”, causing severe flooding in the inner harbor area.

Early warnings for all (EW4All)



EW4ALL Pillar 2



Disaster risk knowledge

Systematically collect data and undertake risk assessments

- Are the hazards and the vulnerabilities well known by the communities?
- What are the patterns and trends in these factors?
- Are risk maps and data widely available?



Detection, observations, monitoring, analysis and forecasting of hazards

Develop hazard monitoring and early warning services

- Are the right parameters being monitored?
- Is there a sound scientific basis for making forecasts?
- Can accurate and timely warnings be generated?



Preparedness and response capabilities

Build national and community response capabilities

- Are response plans up to date and tested?
- Are local capacities and knowledge made use of?
- Are people prepared and ready to react to warnings?



Warning dissemination and communication

Communicate risk information and early warnings

- Do warnings reach all of those at risk?
- Are the risks and warnings understood?
- Is the warning information clear and usable?

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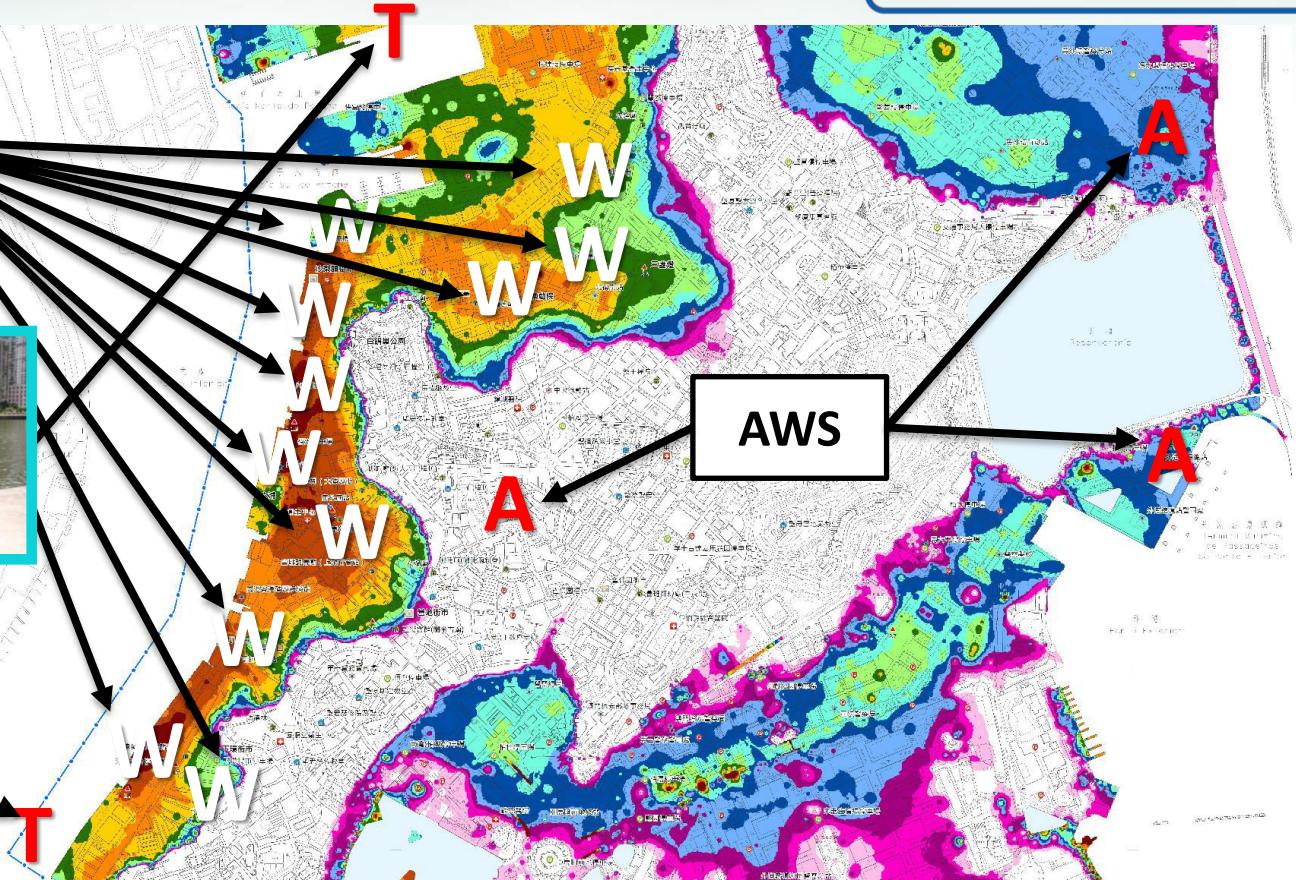


Monitoring network

**Water Level
Stations**
(Total 21 in Macao)



Tide Stations



EW4ALL Pillar 2

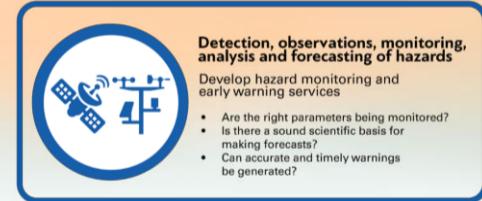
Water Level Stations



The existing water level stations require **a lot of space**, but the walkways in Macao are very **narrow**.

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Water Level Stations

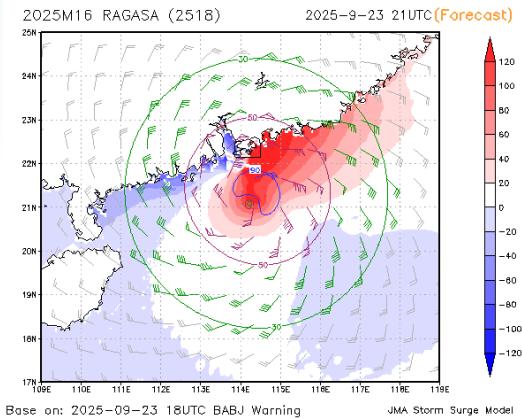
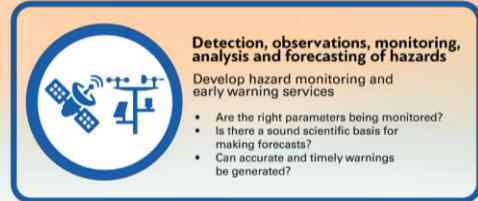


Therefore, we tested several **small wireless water level stations** near the existing stations. This gives us more **flexibility** in set up water level stations.

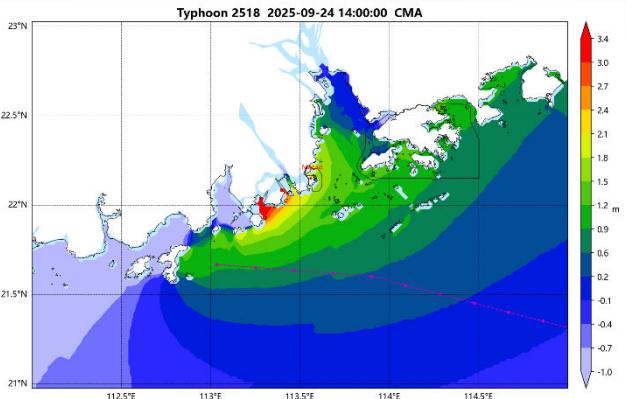


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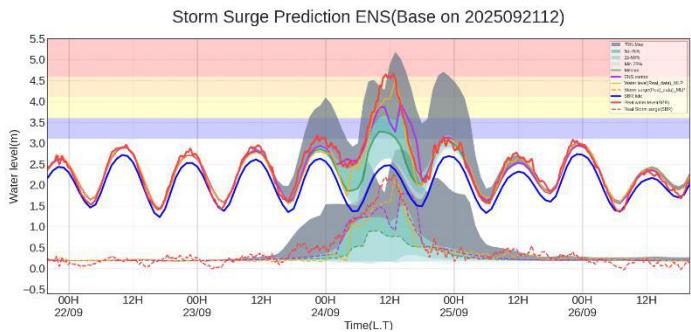
Storm Surge Models



JMA Storm Surge Model (2013)



NMEFC Storm Surge Model



Machine-Learning-Based Model for Storm Surge

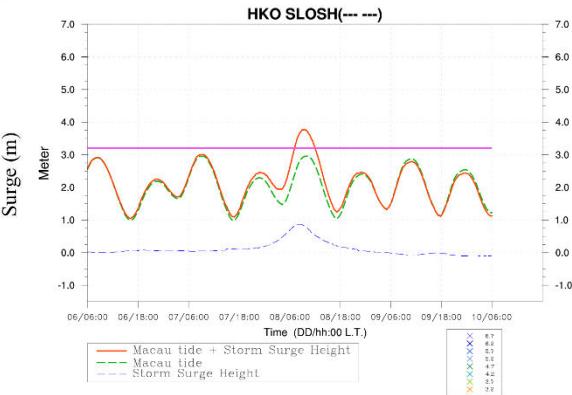
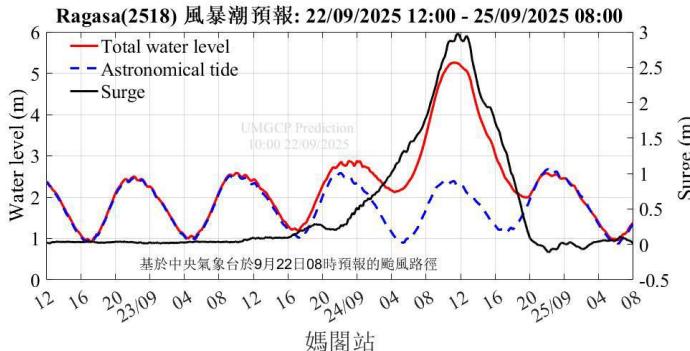
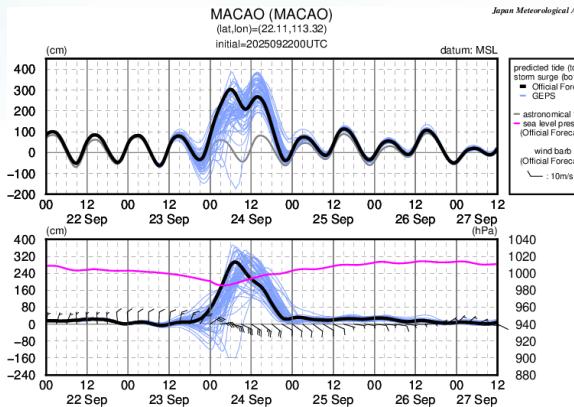
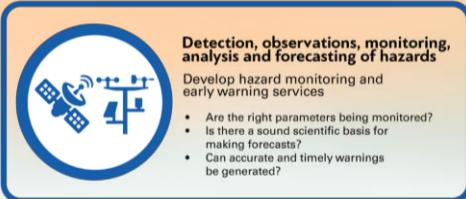


国家海洋环境预报中心

National Marine Environmental Forecasting Center

EW4ALL Pillar 2

Storm Surge Models



RSMC-TOKYO

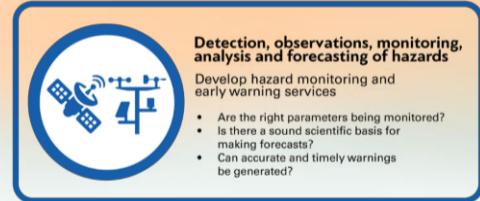
UM Storm Surge Model

HKO SLOSH



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“3-Region Sessions”



海洋预报网
www.hyyb.org

香港附近海域将出现大浪到巨浪
(2025-07-19T11:00:00—2025-07-22T11:00:00)

澳门附近海域将出现大浪到巨浪
(2025-07-19T11:00:00—2025-07-22T11:00:00)

19日夜间至20日：香港、澳门近岸海域海浪逐渐增大，将由0.5-1.0米的轻浪增至2.5-4.5米的大浪到巨浪。上述海域浪高预计21日仍维持大浪以上，21日后期起浪高开始减小。

南海预报减灾中心

香港天文台



澳門特別行政區政府
Governo da Região Administrativa Especial de Macau
地球物理氣象局
Direcção dos Serviços Meteorológicos e Geofísicos

香港特別行政區政府



EW4ALL Pillar 3



Disaster risk knowledge

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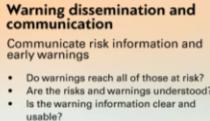
Warning dissemination and communication

Communicate risk information and early warnings

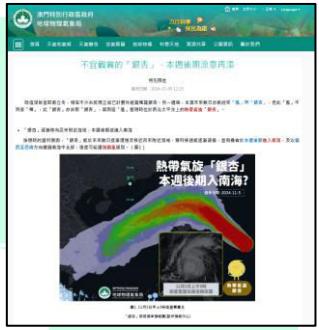
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EW4ALL Pillar 3

Information dissemination strategy



Tropical cyclone has formed



(One week ago)

Preliminary summary

Gradually moved away



熱帶氣旋消息

位於菲律賓呂宋附近的熱帶氣旋「桃芝」，將於週二(11月12日)初時進入本澳800公里範圍，本局屆時會發出一號風球。按照現時預測路徑，「桃芝」有機會於本週中後期在本澳以南約200公里掠過，但其路徑及強度仍存在不確定性。而在東北季風共同影響下，預測本週中後期本澳風力增強及驟雨增多。本局將密切監察其發展動態，請市民密切留意本局最新天氣資訊。(於 2024年11月11日17時40分更新)

Tropical cyclone is enter within 800 kilometers of Macao

(One to two days ago)

(Within 24 hours)

受熱帶氣旋「桃芝」影響可能發佈之警告

在澳門時間 2024-11-14 02:00 更新。

警告信號	預計可能發佈時段	可能性
三號風球	已發出	
八號風球	14日清晨	中等
藍色風暴潮警告	較低	

After issuing a tropical cyclone warning



EW4ALL Pillar 3

Information dissemination strategy



Tropical Cyclone Information



15 times
(16-22 SEP)

Extra information



9 times
(17-24 SEP)

EW4ALL Pillar 3

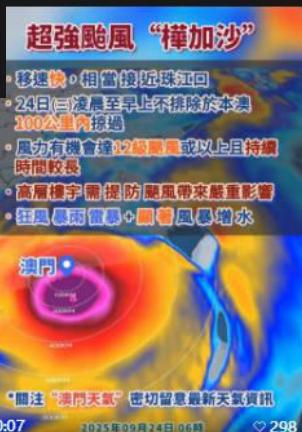
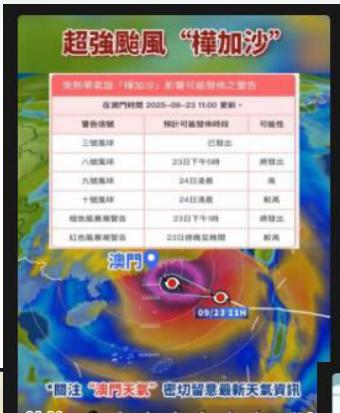
Short videos



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TV broadcasts



During the impact of “Ragasa”, we conducted **60 times** live TV broadcasts in three languages over four days.

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Internal meetings with government departments



After issued the **Typhoon signals no.1**, SMG will hold **internal meetings** with various **government departments**.

These meetings will cover the **typhoon's trajectory**, **potential warnings**, and the **risk of storm surge**, let other government departments to **prepare in advance**.

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Preparations by all government departments



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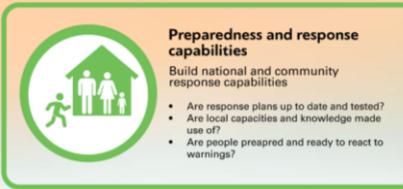
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Channel clearing and tree trimming

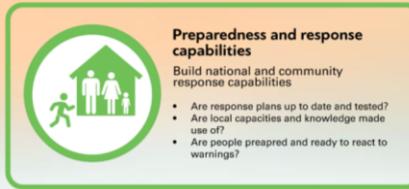


The Municipal Affairs Bureau
(IAM)



EW4ALL Pillar 4

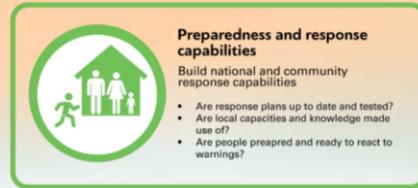
Evacuation operation



After the orange storm surge warning was issued, security authorities help people in low-lying areas evacuate to safety

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Emergency shelters

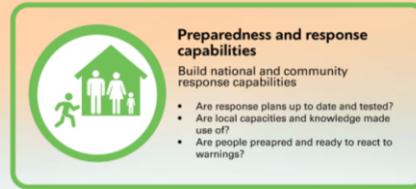


澳門特別行政區政府
社會工作局
GOVERNO DA RAEM
INSTITUTO DE ACÇÃO SOCIAL

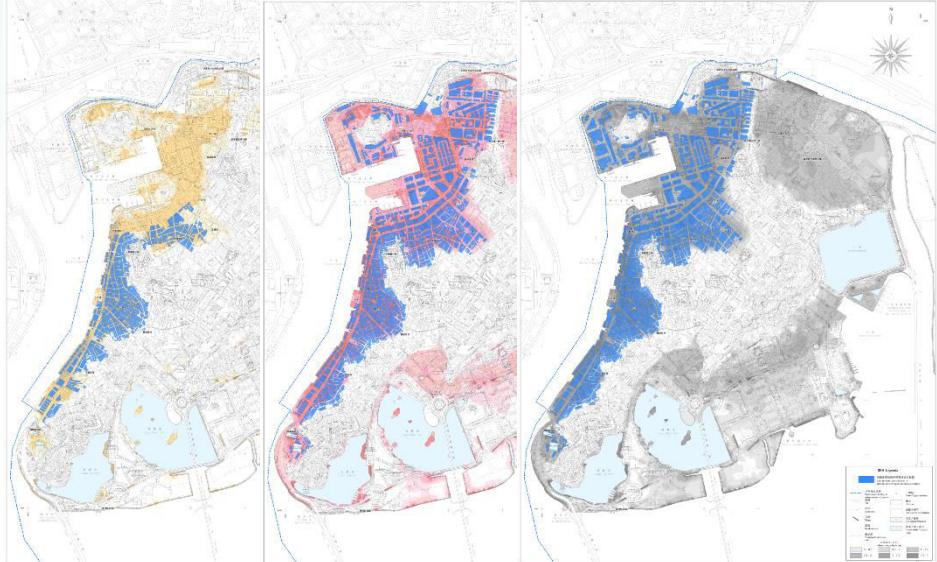
Social Welfare Bureau (IAS) has set up **17 emergency shelters** throughout Macao, which are opened to the public during typhoons and storm surges to allow citizens or tourists **to take temporary refuge**.

EW4ALL Pillar 4

Power suspension

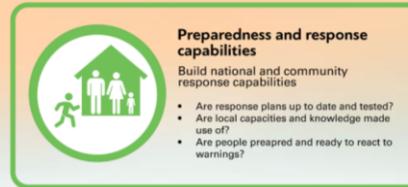


- Power suspension in low-lying areas in advance
- To avoid explosions due to electrical leakage, damage to power facilities and speed up power restoration after the water has receded.



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Annual typhoon civil defense exercise



Preparedness and response capabilities

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Annual exercises in SMG



SMG conducts annual exercises focusing on **power**, **network**, and **information dissemination**.

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Areas affected during different storm surge warning levels



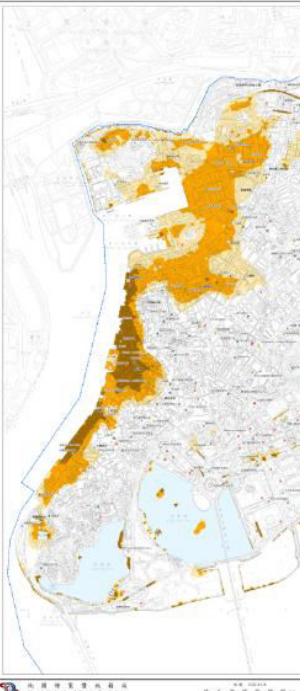
藍色風暴潮預期受影響地區
Área prevista a ser afectada por "Storm Surge" azul



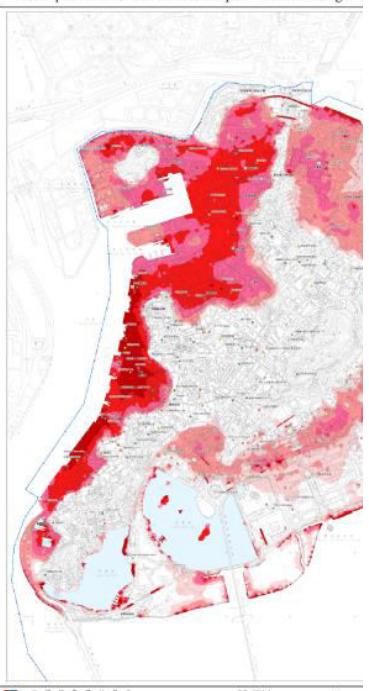
黃色風暴潮預期受影響地區
Área prevista a ser afectada por "Storm Surge" amarelo



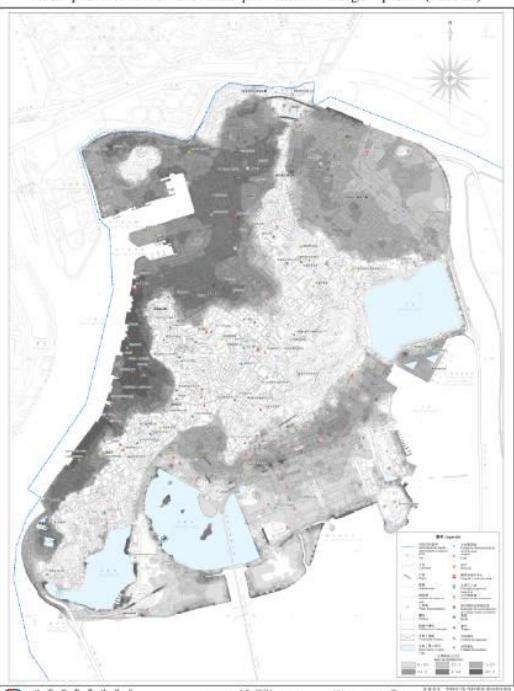
橙色風暴潮預期受影響地區
Área prevista a ser afectada por "Storm Surge" laranja



紅色風暴潮預期受影響地區
Área prevista a ser afectada por "Storm Surge" vermelha



黑色風暴潮預期受影響地區(澳門)
Área prevista a ser afectada por "Storm Surge" preto (Macau)



EW4ALL Pillar 1

Storm surge marking sticker

< 0.5m  > 2.5m



Each color corresponds to a storm surge warning category of a certain water level height.

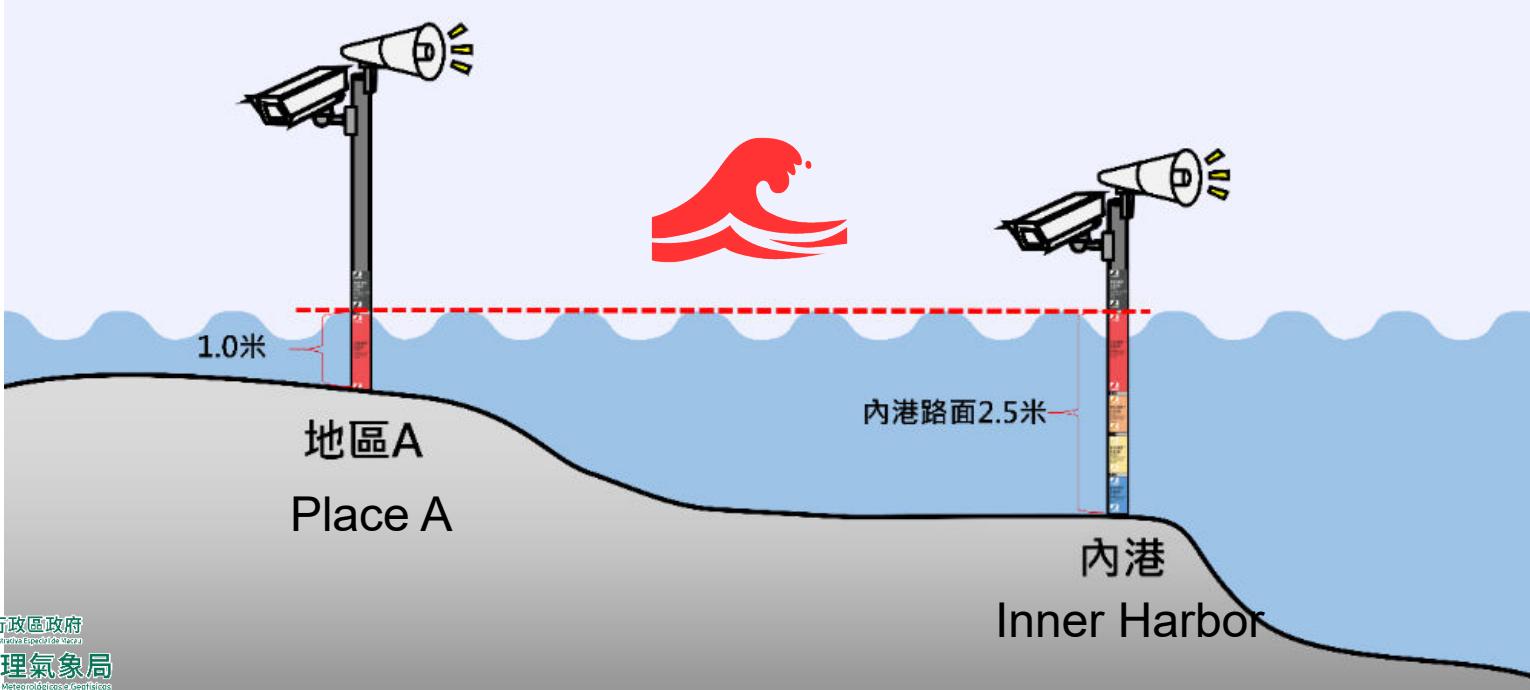


EW4ALL Pillar 1

Storm surge marking sticker



Demonstration: Situation Under **Red Warning**



EW4ALL Pillar 1

Storm surge marking sticker on poles



EW4ALL Pillar 1

Storm surge marking sticker on water level stations



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Building exteriors and public parking entrances



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Total Number of Stickers in Macao



	Place	Total
1.	Pole	150
2.	Exterior wall of building	65
3.	Public parking entrances	30
4.	Water level station	22



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Visits & Dramas



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Bus exterior and interior promotion



EW4ALL Pillar 1

Videos and Audio



Colocação do papel autocolante

1.0M

2,5 metros acima do pavimento rodoviário

YouTube

Aviso de "Storm Surge"

澳門地球物理暨氣象局頻道 4720訂閱量

風暴潮警報級別

第一級警報/藍色	預測水位將高於路面 0.5米以下
第二級警報/黃色	預測水位將高於路面 0.5至1.0米
第三級警報/橙色	預測水位將高於路面 1.0至1.5米
第四級警報/紅色	預測水位將高於路面 1.5至2.5米
第五級警報/黑色	預測水位將高於路面 2.5米以上

我們要因應氣象局發出的風暴潮警報級別
considerando em cada nível de alerta divulgada pelo SMG

風暴潮！點算呀！("Storm Surge"! O que devo fazer?)

澳門地球物理暨氣象局頻道 4720訂閱量

內港 紅街市 媽閣 亞馬喇 科學館

由於各區的地勢不同，導致風暴潮水浸有差異
a altura de inundações causada por "storm surge" varia.

風暴潮 漫幾高；睇貼紙，就知到

澳門地球物理暨氣象局頻道 4720訂閱量

EW4ALL Pillar 1

Promotional Souvenirs





Thank You for Your Attention