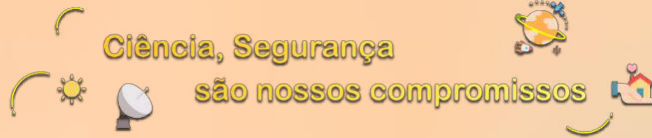




澳門特別行政區政府
Governo da Região Administrativa Especial de Macau
地球物理氣象局
Direcção dos Serviços Meteorológicos e Geofísicos



Storm Surge Warning Services in Macao

Macao, China

WONG MAN CHI, Harry



ESCAP/WMO Typhoon Committee
20th Integrated Workshop/High-level forum
Macao, China
2 - 5 December, 2025

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

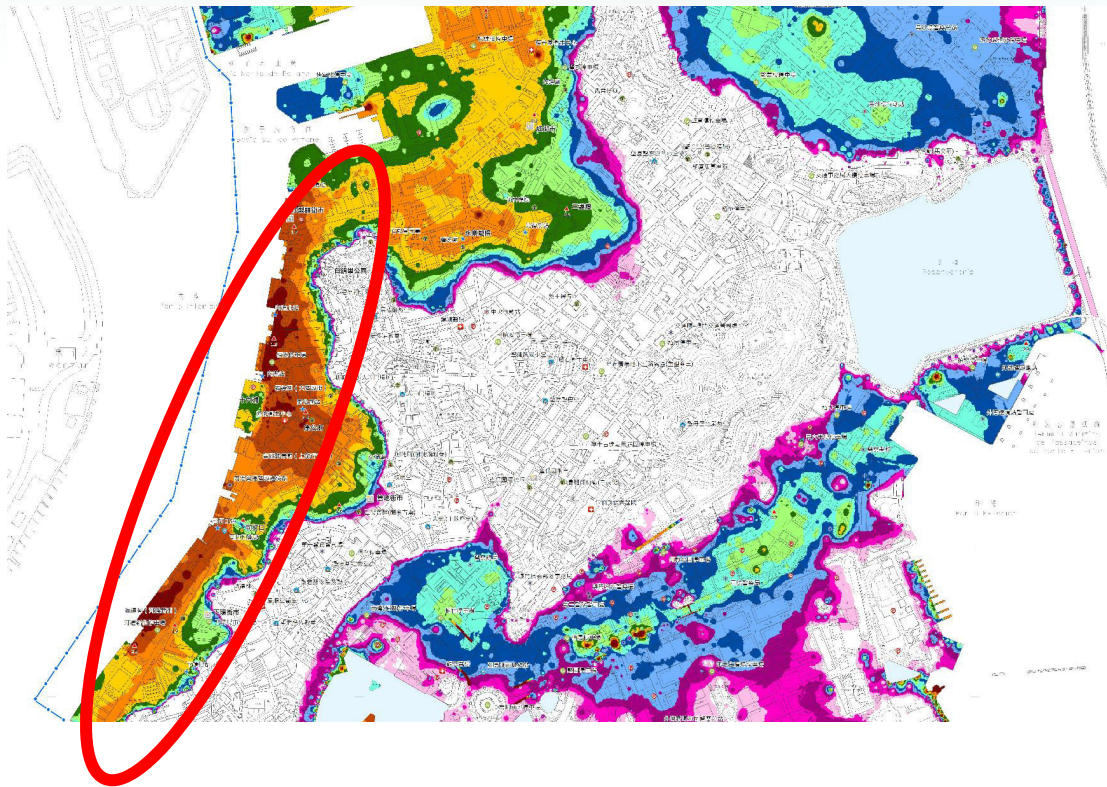


Centuries ago, Macao was an **important port** on the southern coast of China.

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



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?



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)



WMO



IFRC
FICR



UNDRR
UN Office for Disaster Risk Reduction



Disaster risk knowledge

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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?



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

EW4ALL Pillar 2



Disaster risk knowledge

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EW4ALL Pillar 2



Detection, observations, monitoring, analysis and forecasting of hazards

Develop hazard monitoring and early warning services

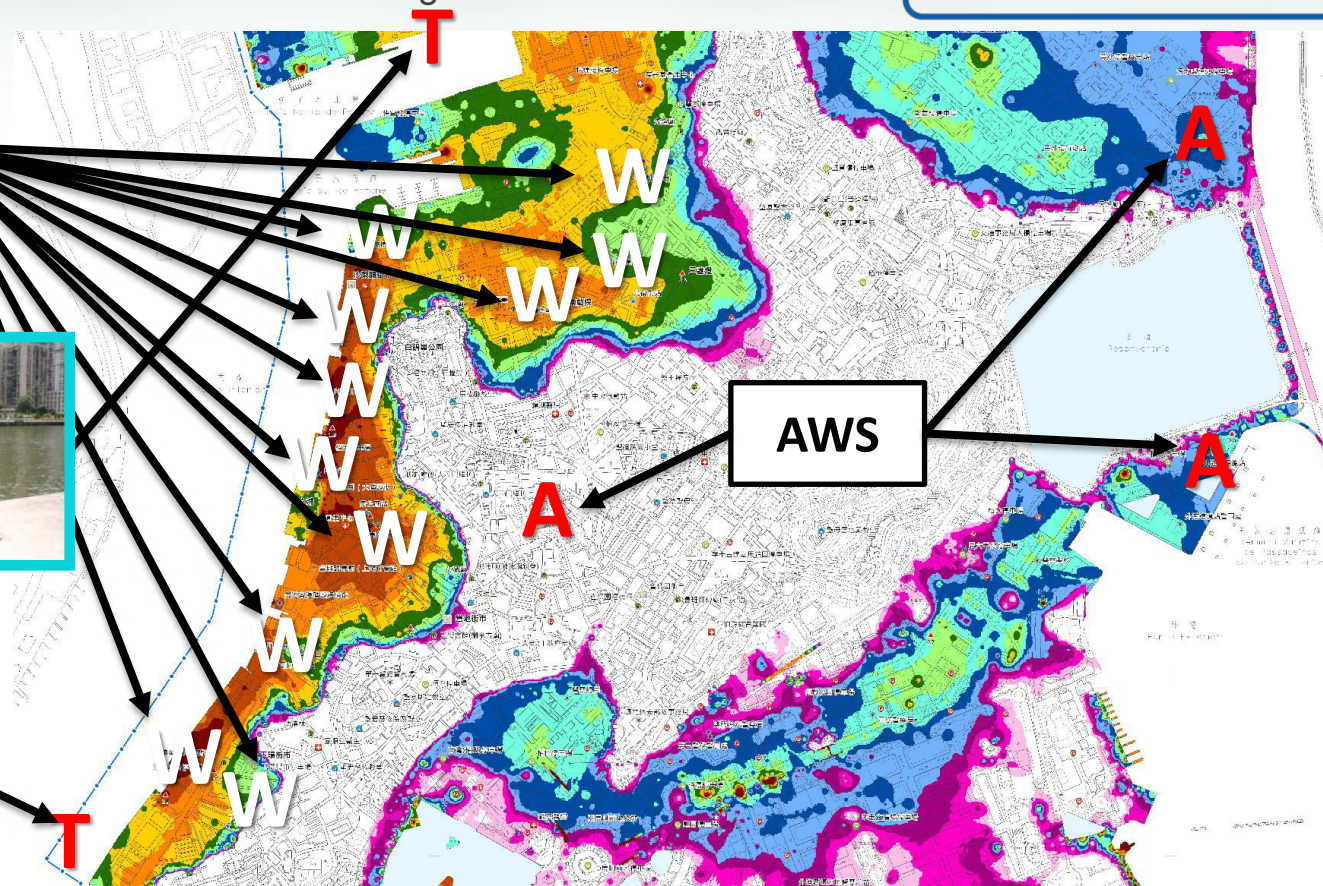
- Are the right parameters being monitored?
- Is there a sound scientific basis for making forecasts?
- Can accurate and timely warnings be generated?

Monitoring network

Water Level Stations
(Total 21 in Macao)



Tide Stations



AWS



澳門特別行政區政府
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地球物理氣象局
Direcção dos Serviços Meteorológicos e Geofísicos

EW4ALL Pillar 2

Water Level Stations



Detection, observations, monitoring, analysis and forecasting of hazards

Develop hazard monitoring and early warning services

- Are the right parameters being monitored?
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- Can accurate and timely warnings be generated?



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



EW4ALL Pillar 2

Water Level Stations

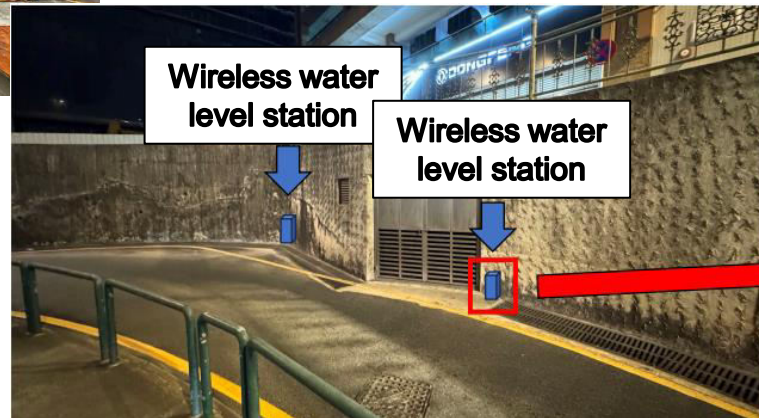


Detection, observations, monitoring, analysis and forecasting of hazards

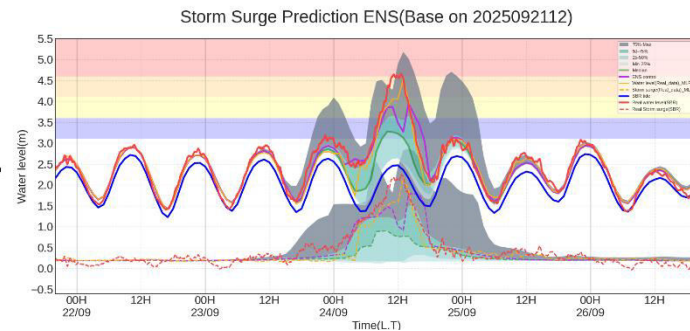
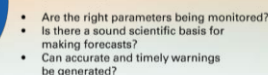
Develop hazard monitoring and early warning services

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

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



Storm Surge Models



Machine-Learning-Based Model for Storm Surge



EW4ALL Pillar 2

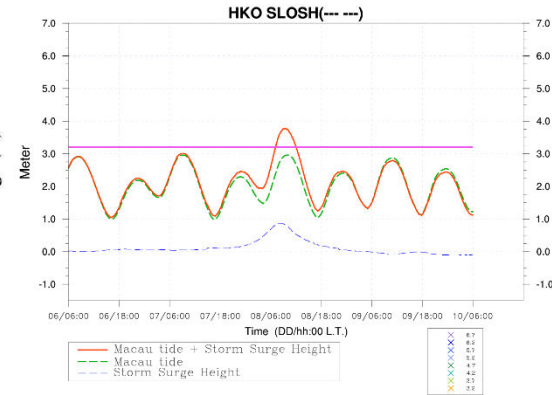
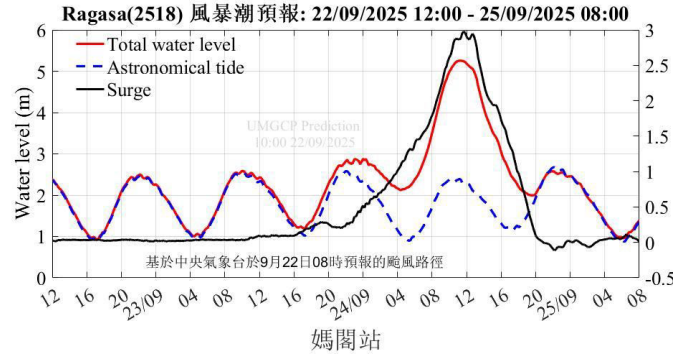
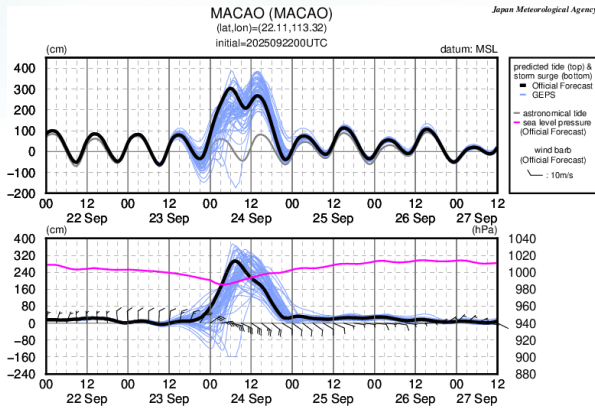
Storm Surge Models



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?
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RSMC-TOKYO

UM Storm Surge Model

HKO SLOSH



EW4ALL Pillar 2

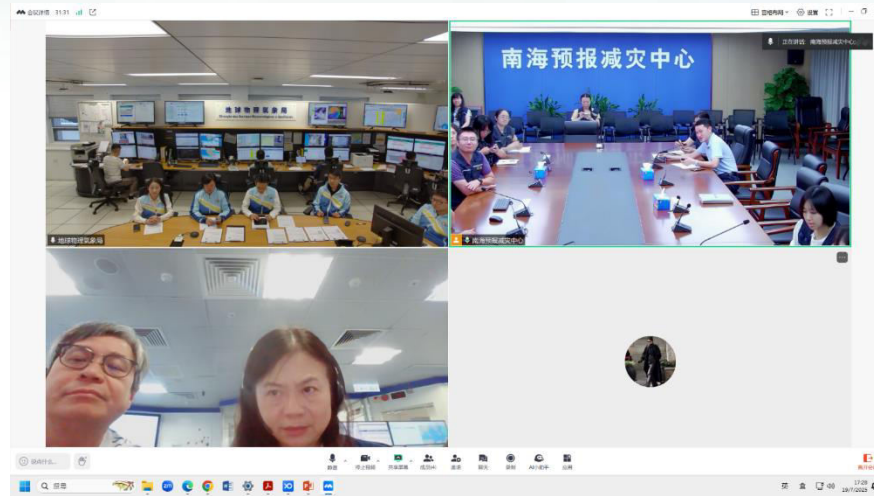
“3-Region Sessions”



Detection, observations, monitoring, analysis and forecasting of hazards

Develop hazard monitoring and early warning services

- Are the right parameters being monitored?
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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



香港天文台

HONG KONG OBSERVATORY



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

EW4ALL Pillar 3



Disaster risk knowledge

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Detection, observations, monitoring, analysis and forecasting of hazards

Develop hazard monitoring and early warning services

- Are the right parameters being monitored?
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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?
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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?

EW4ALL Pillar 3

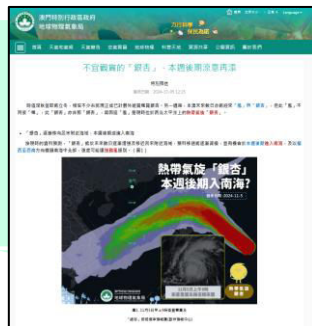
Information dissemination strategy



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?

Tropical cyclone has formed



(One week ago)

(Gradually moved away)

Preliminary summary



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。本屆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)

(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	

Tropical cyclone is enter within 800 kilometers of Macao

After issuing a tropical cyclone warning

澳門
熱帶氣旋信號

8▲ 8▲
西北NW 東北NE

1T

3L

8▼ 8▼
西南SW 東南SE

9X

10+



EW4ALL Pillar 3

Information dissemination strategy



Tropical Cyclone Information

澳門特別行政區政府
地球物理氣象局

現時警告 熱帶氣旋消息

位於西北太平洋的熱帶氣旋「樺加沙」，預料未來數日持續向西北偏西方向移動，強度會顯著增強，不排除達強颱風或以上級別。

按照現時預測路徑，「樺加沙」下週初將移入南海北部，由於預料其環流相當廣闊，加上受東北季風共同影響，本澳下週二稍後開始(9月23日)風勢將顯著增強，下週中(9月24至25日)有頻密大驟雨及雷暴，同時亦可能出現較明顯的風暴潮，但其移動路徑及強度仍存在不確定性。請市民密切留意本局最新天氣資訊，提前做好防風防水浸措施。(於 2025年09月19日17時40分 更新)

15 times
(16-22 SEP)

Extra information

「樺加沙」將對本澳造成顯著影響，嚴防風暴潮水浸

特別推送
發佈日期: 2025-09-20 17:00

根據最新資料預測，未來一週將有兩股熱帶氣旋進入南海，預料週末及下週中「米娜」跟蹤去，但本澳即將迎來另一熱帶氣旋「樺加沙」，且預料將對本澳造成顯著影響，詳細情況如下：

- 「米娜」環流相當細小但距離接近

氣象局呼籲市民做好應對超強颱風「樺加沙」的安全措施

新聞
發佈日期: 2025-09-22 16:33

超強颱風「樺加沙」即將進入南海，預料將會對本澳造成顯著的影響，與前次「天鴿」、「山竹」相似的影響程度。氣象局呼籲市民留意一切海濱設施及洪水浸的預防措施，以確保安全。具體包括：

- 密切留意氣象局最新天氣消息，以獲悉戶外活動的安排；
- 檢查及加固門窗、門、窗、牆及玻璃窗玻璃；
- 檢查地盤及屋頂有否鬆動及水浸；
- 儲備足夠的食物、飲用水及生活用水；
- 準備應急包，內含充電寶、手提電、急救用品及必需藥物等物品。

「樺加沙」打破多項氣象紀錄

新聞
發佈日期: 2025-09-24 21:45

超強颱風「樺加沙」為本澳帶來顯著的影響，並創下多項氣象紀錄，究竟「樺加沙」有何特點？一齊回顧一下—

- 「樺加沙」打破多項氣象紀錄

「樺加沙」以超強颱風級數來澳，並打破多項氣象紀錄，其中包括：打破了本周自1968年有紀錄以來，首次於同一年內，兩度發出十級風球；以及全澳開風最長的十級風球，達10.5小時。(圖1)

「樺加沙」回歸 今年第2個 10+

澳門

「樺加沙」記錄回顧

- 最高10級風球—10.5小時
- 自1968年以來，首次於一年內發出兩次10級風球
- 最遠距離的10級風球—距離本澳90公里
- 今年第11個影響澳門的熱帶氣旋—有記錄以來第二多

9月24日 上午11時
「樺加沙」最接近澳門時的衛星雲圖

發佈日期: 2025-09-24

澳門特別行政區政府
地球物理氣象局

9 times
(17-24 SEP)

EW4ALL Pillar 3

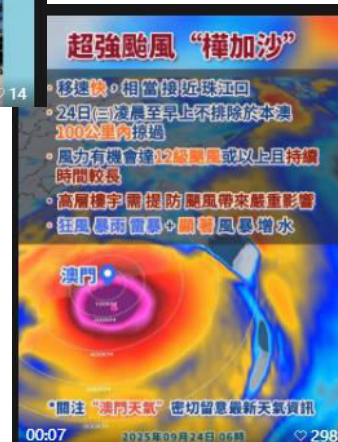
Short videos



Warning dissemination and communication

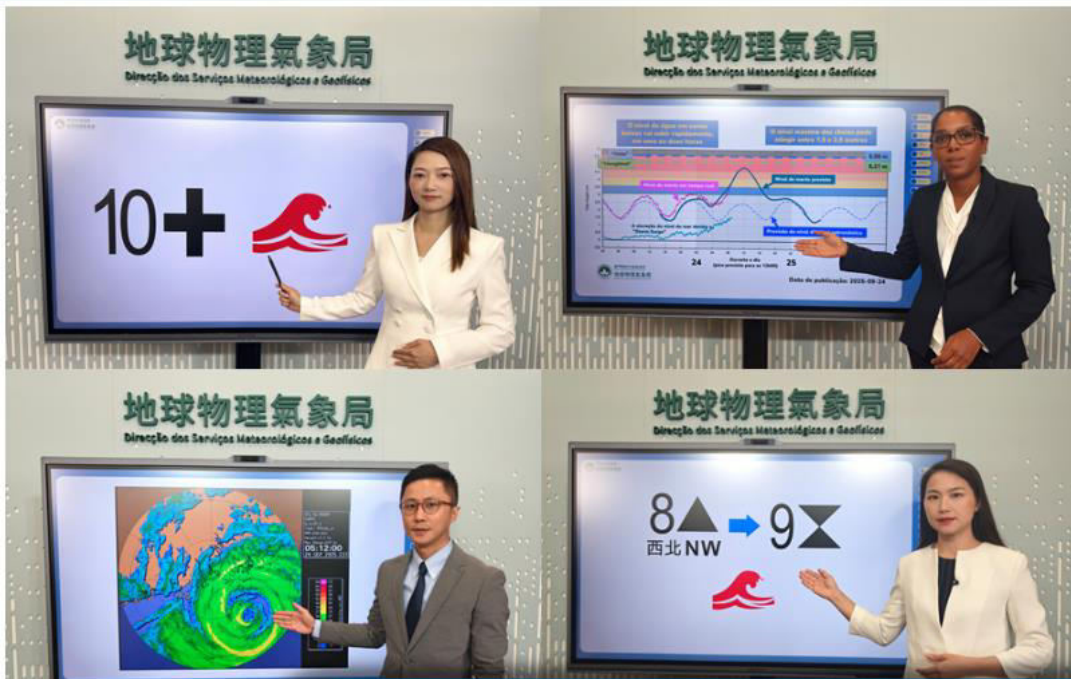
Communicate risk information and early warnings

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



EW4ALL Pillar 3

TV broadcasts



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



EW4ALL Pillar 3

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**.

EW4ALL Pillar 3

Preparations by all government departments



Warning dissemination and communication

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EW4ALL Pillar 4



Disaster risk knowledge

Systematically collect data and undertake risk assessments

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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?
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Warning dissemination and communication

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EW4ALL Pillar 4

Channel clearing and tree trimming



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The Municipal Affairs Bureau
(IAM)



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

EW4ALL Pillar 4

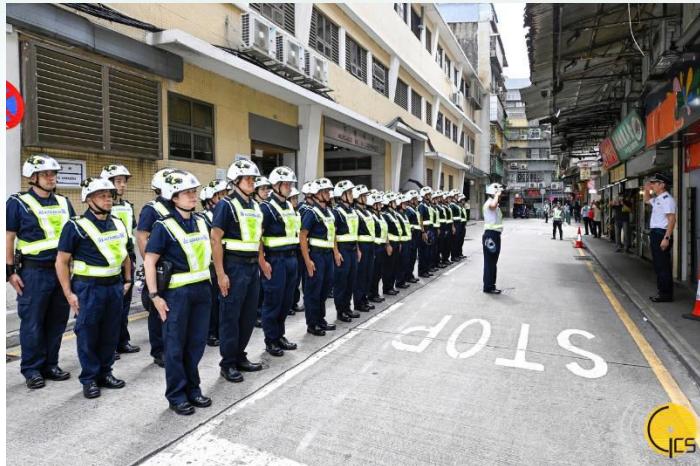
Evacuation operation



Preparedness and response capabilities

Build national and community response capabilities

- Are response plans up to date and tested?
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警察總局
SERVIÇOS DE POLÍCIA UNITÁRIOS

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

EW4ALL Pillar 4

Emergency shelters



Preparedness and response capabilities

Build national and community response capabilities

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

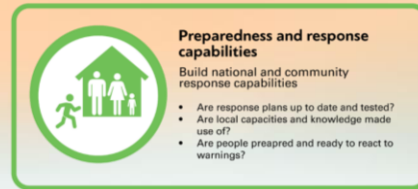
Social Welfare Bureau (IAS) has set up **17 emergency shelters** throughout Macao, which are opened to the public during typhoons and storm surges to allow citizens or tourists **to take temporary refuge**.



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

EW4ALL Pillar 4

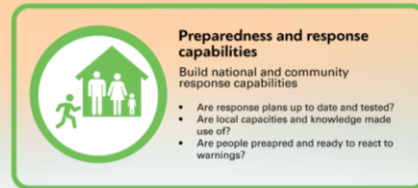
Power suspension



- 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.

EW4ALL Pillar 4

Annual typhoon civil defense exercise



- To enhance public awareness of disaster prevention and mitigation, and improve Macao's comprehensive response to natural disasters, **the civil defense structure** is conducting the annual typhoon civil defense exercise under the **codename "Crystal Fish"** every year. The exercise involves the participation of government departments, associations, professional organizations, and citizens.



EW4ALL Pillar 4

Annual exercises in SMG



Preparedness and response capabilities

Build national and community response capabilities

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



EW4ALL Pillar 1



Disaster risk knowledge

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EW4ALL Pillar 1

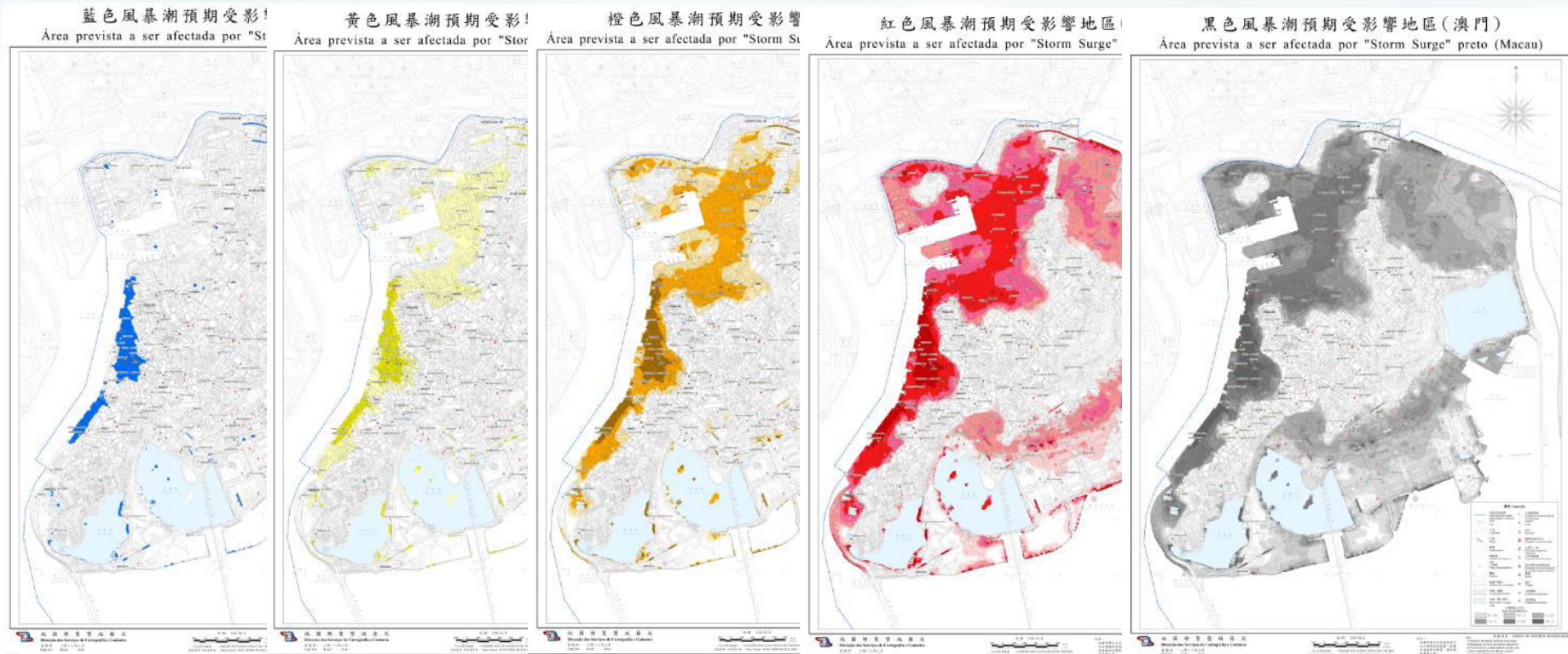
Areas affected during different storm surge warning levels



Disaster risk knowledge

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EW4ALL Pillar 1

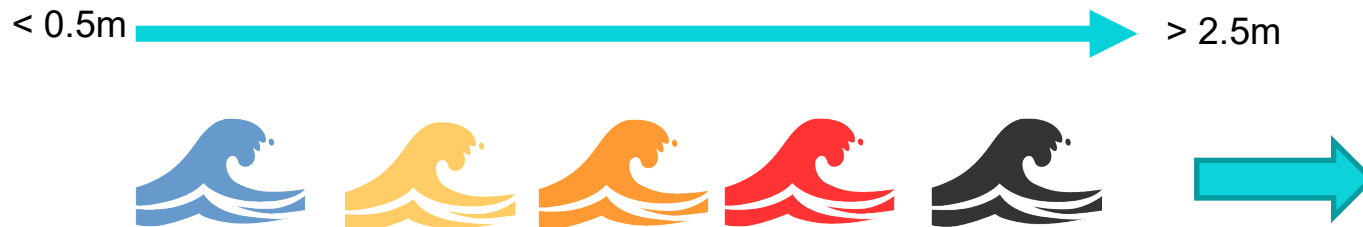
Storm surge marking sticker



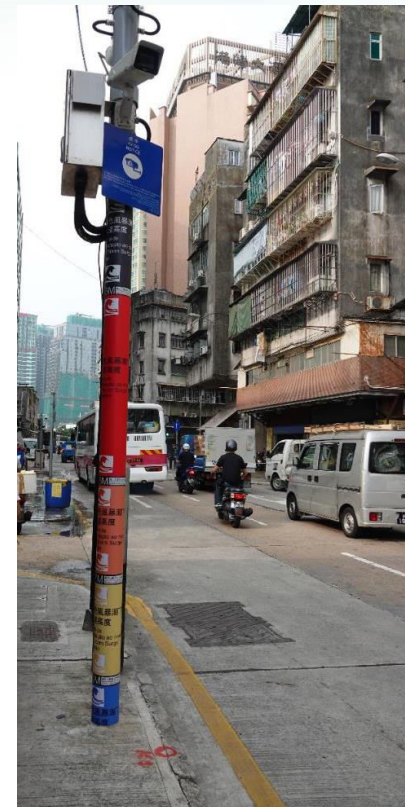
Disaster risk knowledge

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



EW4ALL Pillar 1

Storm surge marking sticker

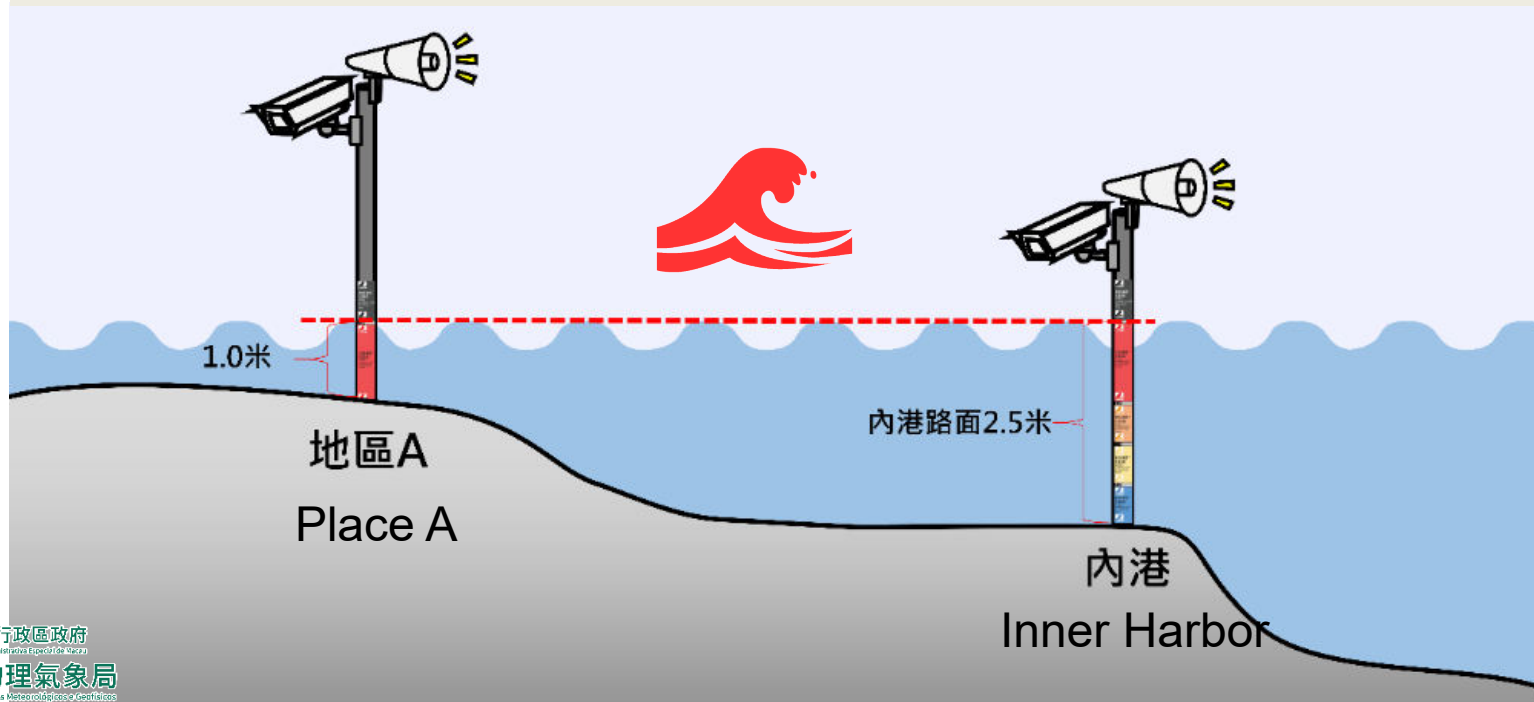


Disaster risk knowledge

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Demonstration: Situation Under **Red Warning**



EW4ALL Pillar 1

Storm surge marking sticker on poles



Disaster risk knowledge

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EW4ALL Pillar 1

Storm surge marking sticker on water level stations



Disaster risk knowledge

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EW4ALL Pillar 1

Building exteriors and public parking entrances



Disaster risk knowledge

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EW4ALL Pillar 1

Total Number of Stickers in Macao



Disaster risk knowledge

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

EW4ALL Pillar 1

Visits & Dramas



Disaster risk knowledge

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EW4ALL Pillar 1

Bus exterior and interior promotion



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?



EW4ALL Pillar 1

Videos and Audio



Disaster risk knowledge

Systematically collect data and undertake risk assessments

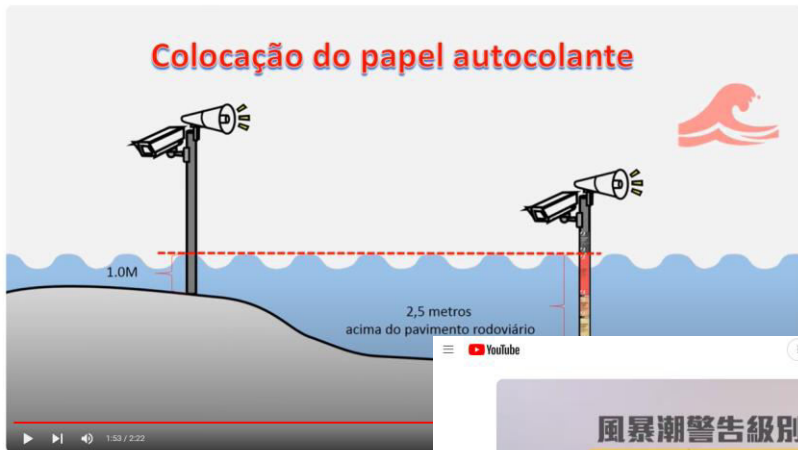
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YouTube

搜尋

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Aviso de "Storm Surge"

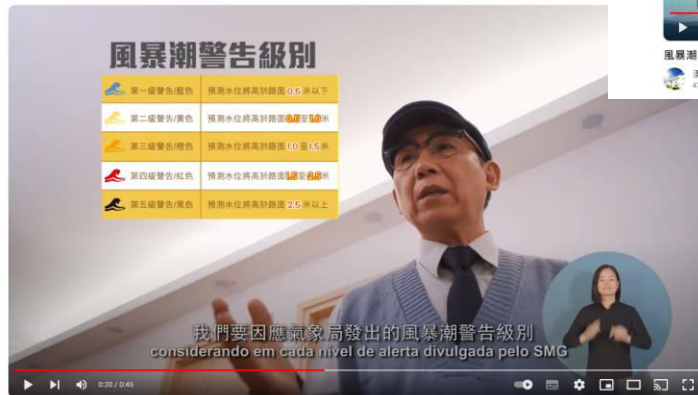
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搜尋



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

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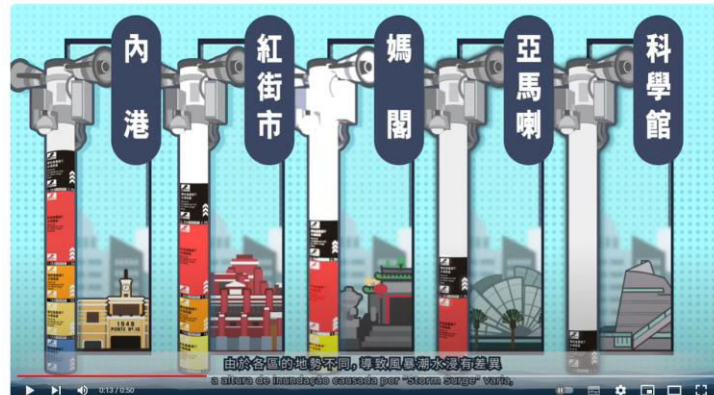
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風暴潮，浸幾高，睇貼紙，就知囉

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澳門特別行政區政府

Governo da Região Administrativa Especial de Macau

地球物理氣象局

Direção dos Serviços Meteorológicos e Geofísicos

EW4ALL Pillar 1

Promotional Souvenirs



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澳門特別行政區政府

Government of the Macao Special Administrative Region

地球物理氣象局

Direcção dos Serviços Meteorológicos e Geofísicos

Thank You for Your Attention