

Coastal Flooding in Hong Kong due to Sea-level Rise

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BACKGROUND

WANDA (溫黛), MANGKHUT (山竹), HATO (天鴿), HAGUPIT (哈格比), UTOR (尤特), VICENTE (韋森特).....

DO YOU STILL REMEMBER THEM?

Typhoon = Chance to Rest (Thoughts: No. 8!)

Typhoon = Delightful **NATURAL DISASTER?**

IS "NATURAL DISASTER" INEVITABLE?

WHY ARE THEY SO FAMOUS?

FATAL, But, Typhoon = **STRONG WIND?**

HOW STRONG ARE THEY? ANYMORE?

A Research on

STORM SURGE (風暴潮)

Storm surge is the **SUDDEN SEA-LEVEL RISE** due to **LOW PRESSURE** and **HIGH WIND SPEED** during the passage of Tropical Cyclones.

After the severe inundation resulting from *Super Typhoon MANGKHUT* in 2018, coastal residents were worried about whether the sea level under storm surge would be even higher in the coming future.

If powerful tropical cyclones approach Hong Kong during the **HIGHEST ASTRONOMICAL TIDE**, the **CUMULATIVE HEIGHT** of the sea level can be astonishing and that some houses could be **FULLY SUBMERGED**, which also implies that it will be **LIFE-THREATENING**.

The Sea Level during the Storm Surge consists of two parts:

- ✓ Storm Surge (Additional Height) &
- ✓ Astronomical Tide (Ordinary Tide)



OBJECTIVES

This study aims to investigate the **EXTENT OF FLOODING** in potentially low-lying areas of Hong Kong due to sea-level rise during the passage of tropical cyclones.

AREA OF RESEARCH

1. Wind-wave Relationship and Coastal Configuration
2. Astronomical Tide and Storm Surge Parameters
3. Analysis & Prediction of Sea Level (From Shallow to Deep)

METHODOLOGY

A) *Rough Estimation based on Historical Data*

3a) Maximum Possible Sea Levels **IF TROPICAL CYCLONES** from 2000 to 2018 **COME AGAIN** at the **HIGHEST ASTRONOMICAL TIDE** [1]

i.e. Maximum Sea Level = Historical Storm Surge (Constant) + Highest Astronomical Tide [1] (Constant)
(Assumption: Height of the Storm Surge in the future will not exceed the Historically Recorded Storm Surge.)

B) *Simulation through*

a Simple Mathematical Storm Surge Model

i.e. Storm Surge (Variable) = Barometric Tide + Wind Stress Tide + Wave Setup

3b) Simulate the Case of *Super Typhoon HATO* in 2017 & Compare the Simulated Result with the Recorded Storm Surge

3c) Design *a Super Tropical Cyclone* & Draw Flooding Maps for Tai O

Background: Illustration of Wind Stress Tide

Central Pressure (Lowest)

[1] The tide data at 11 tide gauge stations were analyzed.

Background: Illustration of Barometric Tide

FINDINGS

MANGKHUT in 2018 is the most powerful tropical cyclone.

Is the above statement true? (Yes / No)

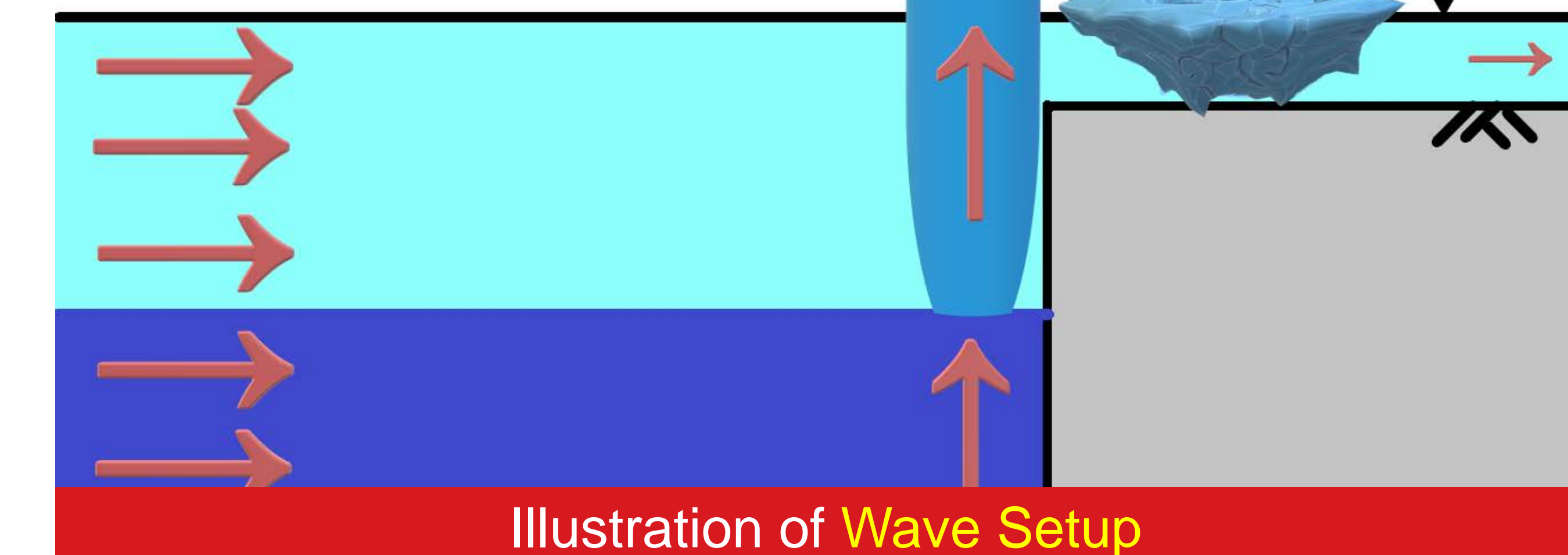
MANGKHUT is just the most powerful tropical cyclone influencing Hong Kong in terms of the height of storm surge induced. Although its lowest central pressure and maximum surface wind reached **900 hPa** and **69 m/s**, these parameters have been weakened before approaching Hong Kong. It is found that *HAIYAN* in 2013 is the most powerful cyclone from 2000 to 2018. Its lowest central pressure and maximum surface wind reached **890 hPa** and **79 m/s**. As its path was far from Hong Kong, it had not affected Hong Kong significantly at the time.

For case 3a, it is found that the height of sea levels at all tide gauge stations will record **AT LEAST 5.4 METRES ABOVE CHART DATUM** (mCD) if *MANGKHUT* comes again at the highest astronomical tide. It shows that the Astronomical Tide is a decisive factor for flooding during a storm surge.

For case 3c, the simulated result shows that the maximum sea level in Tai O could reach **8.06 mCD** if a super tropical cyclone possesses a pressure difference of 20 % larger than *HAIYAN* and a wind speed of 20 % higher than the recorded maximum gust of **256 km/h**. It can severely flood most of the area in Tai O, whether it is the zone of stilt houses, Tai O Road, or zone of public housings.

Breaking Wave

Water Flow



CONCLUSION

People are forgetful, but the consecutive storm surges induced by *HATO* in 2017 and *MANGKHUT* in 2018 have awakened citizens to pay attention to the tide. Hong Kong has been lacking in research on storm surges. It is recommended to incorporate the concept of smart cities to promote storm surge studies.

Remember, High Tide and Low Tide are always by your Side!