

#### Toward a resilient coastal city: performance assessment for adaptive solutions of greengray-blue infrastructure

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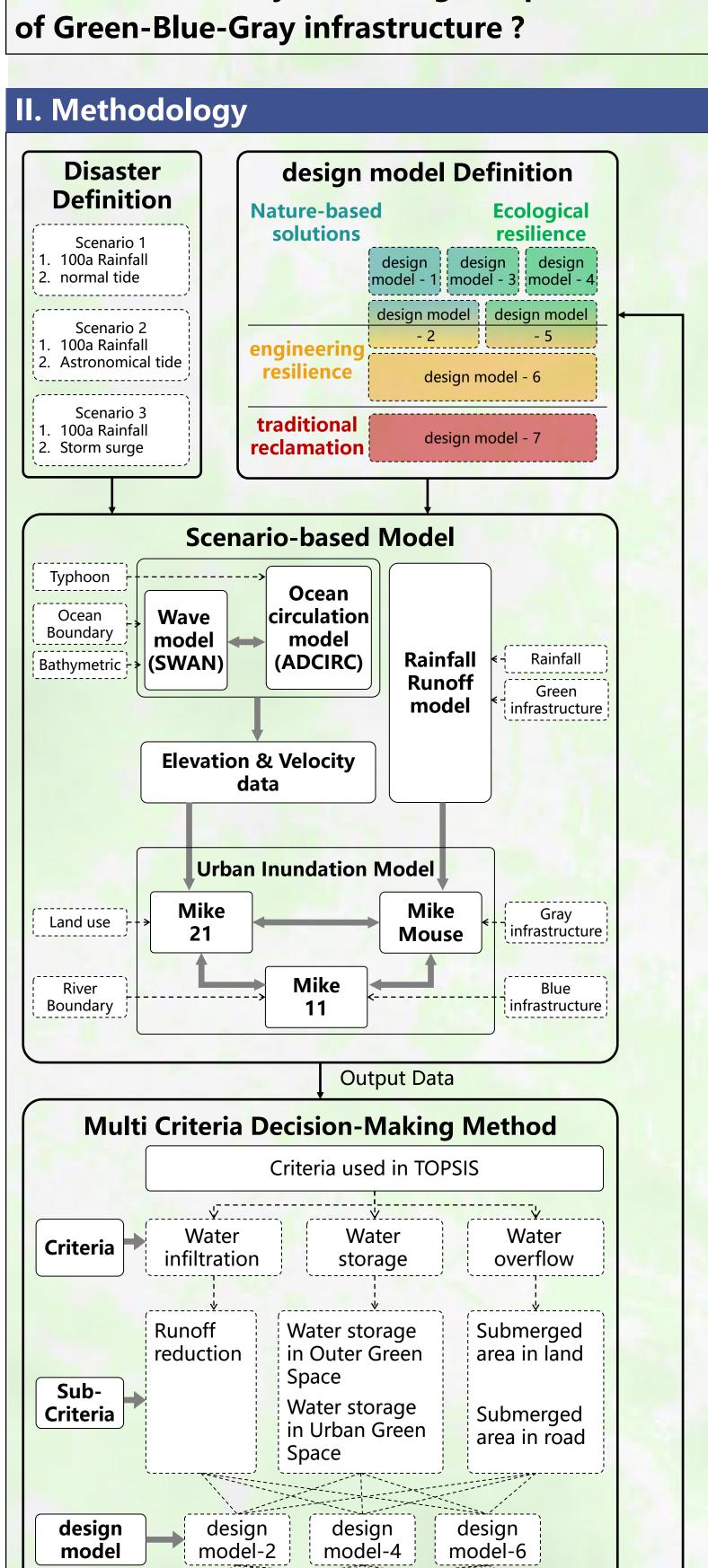
# performance assessment for adaptive solutions of green-gray-blue infrastructure

#### I. Introduction

- The low-elevation landform make coastal area, especially the Guangdong-Hong Kong-Macao Greater Bay Area (GBA), more vulnerable to heavy rainstorms and surge storm in the future.
- Resilience city is an emergent concept applied in urban design model, and disaster management to deal with coastal hazards, such as urban flooding.
- Some measure, such as Nature-based solutions, ecological and engineering resilience, adaptive strategies were implemented to improve resilience performance in GBA.
- Policy makers and urban planners need quantitative method to assess the flood risk and identify the optimal design model.

#### Research question:

Which concept (or measure) can deal with the coastal disaster by evaluating the performance



## V. Conclusion

Using multidisciplinary knowledge via TOPSIS to help policy makers identify the optimal resilience urban design model.

model-3

Whether meet the

goals of flood

resilience

(Spatial design model to Improve coastal resilience)

model-5

model-1

design

model-7

Scenario simulation of Green-Blue-Gray infrastructure can help urban planners understand the pros and cons in various urban design model concepts

- 1. Traditional reclamation design model with high altitude is high-cost, human-made, time-consuming, and low-risk.
- 2. Engineering resilience design model with middle altitude is high-risk while facing extremely rainfall.
- 3. Nature-based solution design model with lowest altitude is low-cost, nature-made, and low-risk, using surrounding green space to retain exceed water.
- 4. Ecological resilience design model with lower altitude low-risk, using dike system and river green space to retain exceed water.

### VI. Future work

## **Transportation model**

- Integrate transportation model into urban inundation model to evaluate the impact of submerge road.
- Use large-scale agent-based dynamic transportation modelling to simulate the variation of urban inundation.

## Control single variable

### **Computational Efficiency**

### VII. Acknowledgement

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#### **III. Scenario-based Model Simulation Disaster Definition** Figure 1 Sea level scenarios rainfall Sea Level Scenario Scenario1 – Normal tide in 23th Aug (predicted by Tide Model Driver) 100y 24h design rainfall Normal tide Time [hours] Scenario2 – Figure 2 100-year rainfall Astronomical tide in Aug (predicted by Tide Model Driver) 100y 24h design rainfall Astronomical tide Storm surge in 23th Aug created by Typhoon Mangkhut (predicted by Scenario3 -100y 24h design rainfall ADCIRC+SWAN) Storm surge design model Definition design model-2 design model-3 design model-5 design model-1 design model-4 design model-6 design model-7 (Nature-based solutions (ecological resilience + design model (Nature-based solutions (Nature-based solutions) (engineering resilience) (traditional reclamation) (ecological resilience) +ecological resilience) + engineering resilience) engineering resilience) Middle Altitude High Altitude Very High Altitude Low Altitude Very Low Altitude Low Altitude Middle Altitude **Elevation** (9-11)(10 - 12 m) $(4-6 \, \text{m})$ (5-7 m)(6 - 8 m)(8 - 10 m)(7 - 9 m)Wide ecological resilience Wide ecological resilience hin engineer resilience Thin engineering dike Thin engineer resilience Thin engineer resilience Green dike + ecological river dike + Nature-based river dike + ecological river **Nature-based low island** infrastructure **Nature-based low island** dike + Urban river space space Wide natural waterways + Blue Wide urban waterways Thin urban waterways Thin urban waterways Wide natural waterways Thin natural waterways Thin urban waterways infrastructure thin urban waterways Fig 03-09 Elevation data Fig 10-16 G-B infrastructure Urban Green Space Outer Green Space Controlled Water Outer Water Fig 17-23 Land use data Residential Culture Commercial Industrial Green Space Water Mixed Use Fig 24-30 Gray infrastructure

#### IV. Result

Fig 80-86 Temporal scale

Fig 87-93 Water Exchange

Urban Surface

Urban Waterway

Pipe Network

Urban Green Space

Outer Green Space

Land

Road

Water Industrial

Outlet

Manhole

Green Space

### TOPSIS – Multi Criteria decision analysis

Using TOPSIS to calculate the score (best distance) based on 6 criteria from scenario simulation, design model – 3 get the best score, design model -1 -2 & -4 get better score.

	It means that Nat							
		design model-1	design model-2	design model-3	design model-4	design model-5	design model-6	design model-7
	Scenario1	0.073398	0.083686	0.074335	0.080277	0.077671	0.114505	0.088329
	Scenario2	0.04504	0.037414	0.028391	0.046688	0.056058	0.106622	0.051531
	Scenario3	0.076086	0.091234	0.079859	0.082779	0.080051	0.115968	0.092434
П	Average scores	0.064841	0.070778	0.060862	0.069915	0.07126	0.112365	0.077431
	wa sala	2	Λ	1	2	Г	7	C

### • Urban Inundation Model – Spatial & temporal scale of flood area and Water Exchange among water subsystem.

Due to high altitude (high cost), design model- more roads and development lands. However,	ns more exceed water than do	esign model-3' s, protects				
Scenario 1 Fig 31-37 Spatial scale  Green Land Road	32	33	34	35	36	37
Fig 38-44 Temporal scale  Land  Road  Urban Green Space  Outer Green Space  7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00	7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00	7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00	7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00	7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00	<b>43</b>	7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15x
Fig 45-51 Water Exchange Urban Surface Urban Waterway Pipe Network  Urban Waterway  Pipe Network  Time [hours]	Time [hours]	Time [hours]  47  0.00 1.00 2.00 3.00 4.00 5.00 6.00 7.00 8.00 9.00 10.00 11.00 12.00 13.00 14.00 15.00 16.00 17.00 18.00 Time [hours]	Time [hours]  48  0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 Time [hours]	Time [hours]  49  1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 Time [hours]	Time [hours]  50  1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 Time [hours]	Time [hours]  51  630 1:00 2:00 8:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 18:00 16:00 16:00 17:00 18:00 18:00
Scenario 2         Fig 52-58           Spatial scale         Green Land Road           Image: Comparison of the compa	53	54	55	56	57	58
Fig 59-65 Temporal scale  Land Road Urban Green Space  Outer Green Space  7:00 8:00 9:00 10:00 12:00 13:00 14:00 15:00	7:500 8:500 9:500 10:500 12:500 13:500 14:500 15:500	7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00	7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00	7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00	7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00	7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:
Fig 66-72 Water Exchange Urban Surface Urban Waterway Pipe Network	Time [hours]  67  2000 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 Time [hours]	Time [hours]  68  0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 Time [hours]	Time [hours]  69  0:00 1:00 2:00 8:00 4:00 8:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 18:00 16:00 16:00 17:00 18:00 Time [hours]	70	71  0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 18:00 16:00 17:00 18:00 Time [hours]	Time [hours]
Scenario 3 Fig 73-79 Spatial scale  Green Land Road  0.02	74	75	76	77	78	79