Scenario-based coastal resilience assessment of Green-Blue-Gray infrastructure
A case study of Marine City, Shenzhen, Greater Bay Area

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Scenario-based coastal resilience assessment of Green-Blue-Gray infrastructure:

A case study of Marine City, Shenzhen, Greater Bay Area

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I. Introduction

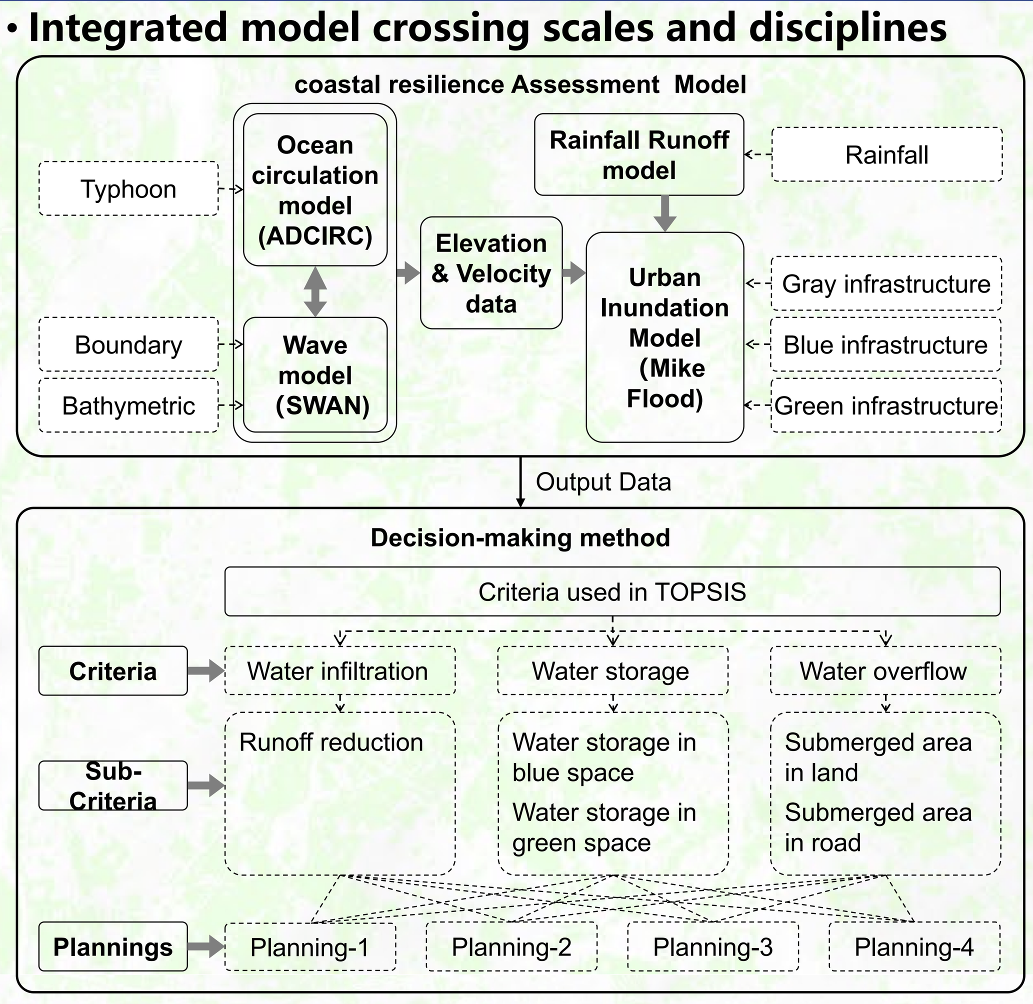
- The low-elevation landform make coastal area, especially **the Guangdong-Hong Kong-Macao Greater Bay Area (GBA),** more vulnerable to **heavy rainstorms** and **surge storm** in the future.
- **Resilience city** is an emergent concept applied in urban planning, and disaster management to deal with 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 planning.

Research question:

How to select the best urban plannings by evaluating the performance of Green-Blue-Gray infrastructure ?

II. Methodology

• Integrated model crossing scales and disciplines



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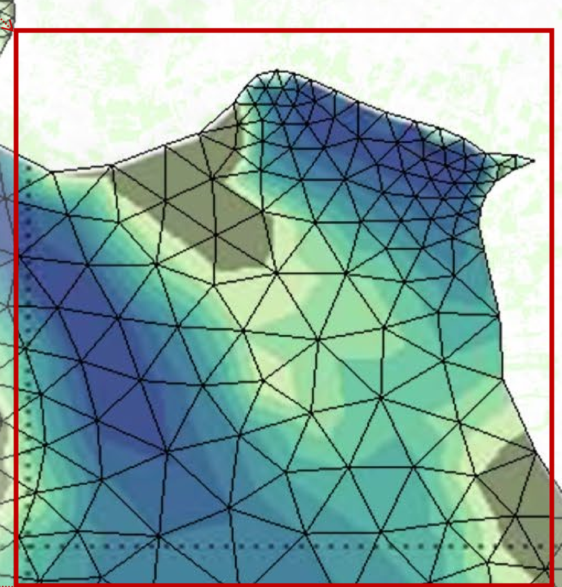
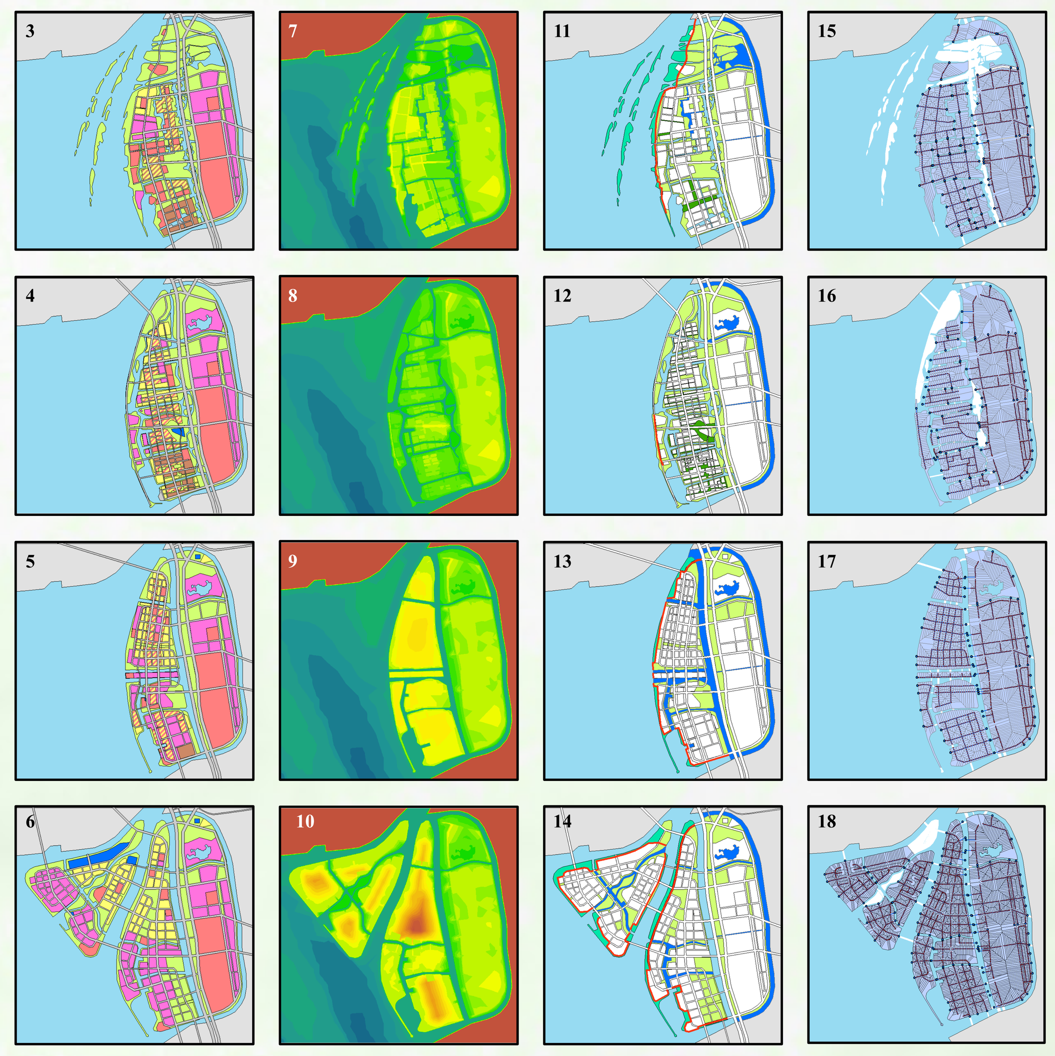


III. Scenario-based Simulation

• Planning Definition

Planning	Elevation	Green infrastructure	Blue infrastructure	Gray infrastructure
Planning-1 (ecological resilience)	Low Altitude (6-8m)	Wide ecological resilience dike system	Wide natural waterways + thin urban waterways	Most of drainage outlets in outer water
Planning-2 (Nature-based solutions)	Low Altitude (4-7m)	Ecological resilience low island	Wide natural waterways	All drainage outlets in outer water
Planning-3 (engineering resilience)	Middle Altitude (8-10m)	Thin green dike + urban green corridor	Thin urban waterways	Some drainage outlets in outer water
Planning-4 (traditional reclamation)	High Altitude (10-12m)	Thin engineering dike + block green space	Thin urban waterways	All drainage outlets in inside water

Fig 3-6 Land use data of 4 plannings / Fig 7-10 Elevation data of 4 plannings / Fig 11-14 G-B infrastructure data of 4 plannings / Fig 15-18 Gray infrastructure data of 4 plannings



• Scenario Definition

Scenario	Sea Level	rainfall
Scenario1 – Normal tide (Normal)	Normal tide in 23th August	100-year 24 hours design rainfall
Scenario2 – Astronomical tide (Astro)	Astronomical tide in August	100-year 24 hours design rainfall
Scenario3 – Storm surge (Storm)	Storm surge in 23th August created by Typhoon Mangkhut	100-year 24 hours design rainfall

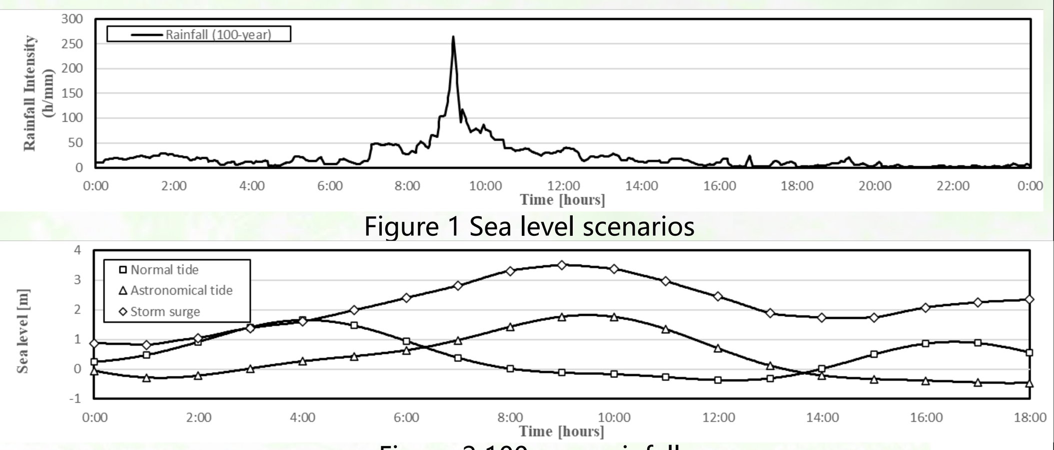
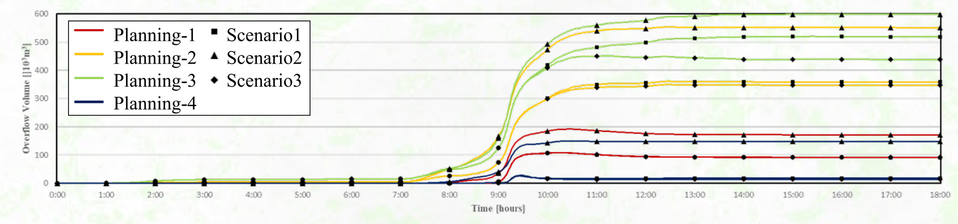


Figure 1 Sea level scenarios

Figure 2 100-year rainfall

IV. Result

- Due to lower altitude, Planning -2 & -3 need to deal with more overflow water than Planning -1 & -4, even in scenario2, which just high sea level meets with peak rainfall.



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

	Planning-1	Planning-2	Planning-3	Planning-4
Scenario1	0.074335	0.073398	0.114505	0.088329
Scenario2	0.028391	0.04504	0.106622	0.051531
Scenario3	0.079859	0.076086	0.115968	0.092434
Average scores	0.060862	0.064841	0.112365	0.077431

- Due to high altitude (high cost), Planning-4 gets the best performance during 3 scenarios. While in lower altitude, Planning-2’s green infrastructure retains more exceed water than Planning-3’s, protects more roads and development lands. However, Planning-1 shows urban greening perform better than outer’s during rainfall.

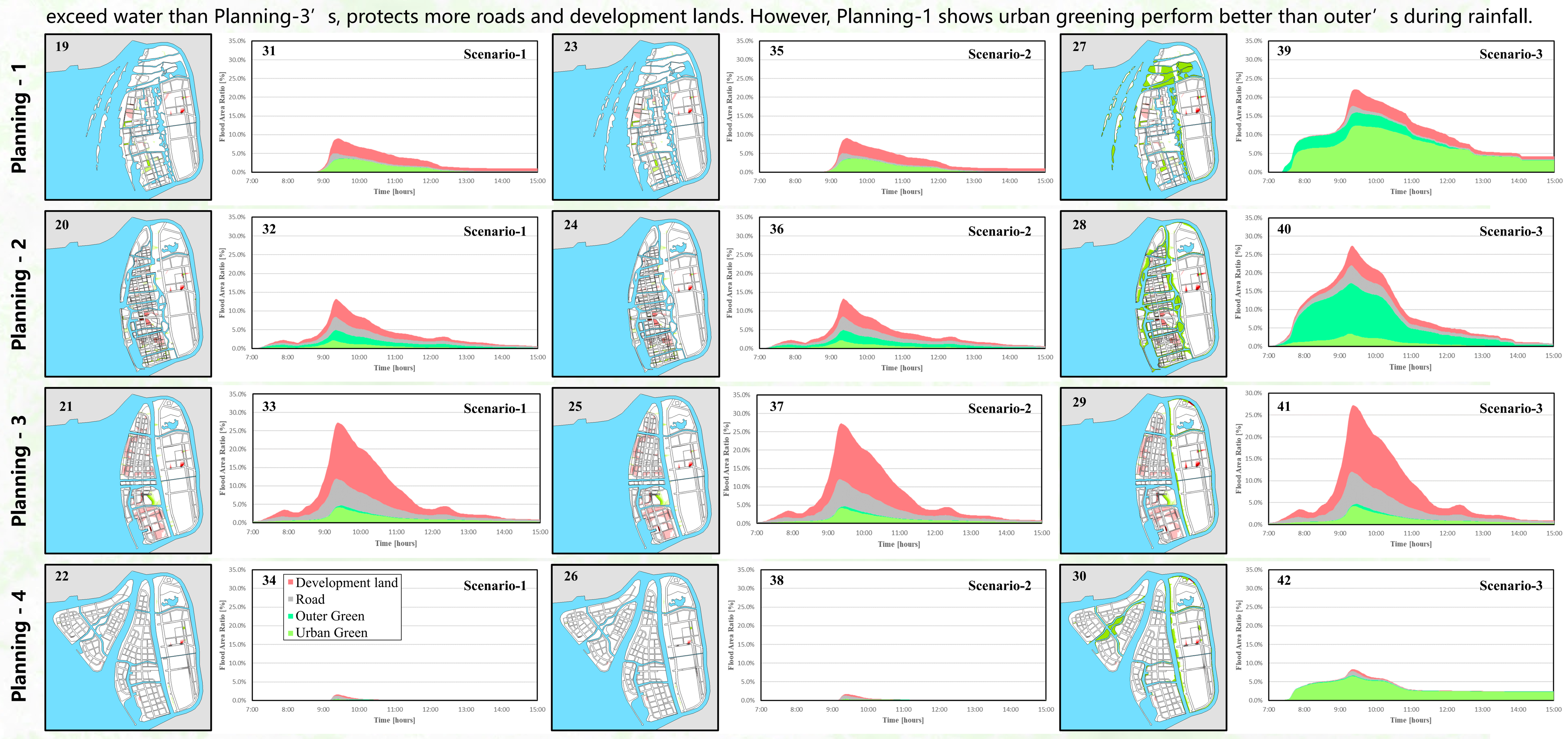


Fig 19-30 Spatial distribution of maximum water depth in 3 scenarios in 4 plannings / Fig 31-42 temporal development of flood area ratio in 3 scenarios in 4 plannings

V. Conclusion

Using **multidisciplinary knowledge** via TOPSIS to help policy makers identify the optimal resilience urban planning.

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

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

VI. Future work

Computational Efficiency

- Use more GPUs to accelerate computing with parallel processing

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.