An integrated scenario-based measuring for transportation resilience
A case study of Pazhou, Guangzhou, Greater Bay Area

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An integrated scenario-based measuring for transportation resilience

A case study of Pazhou, Guangzhou, Greater Bay Area

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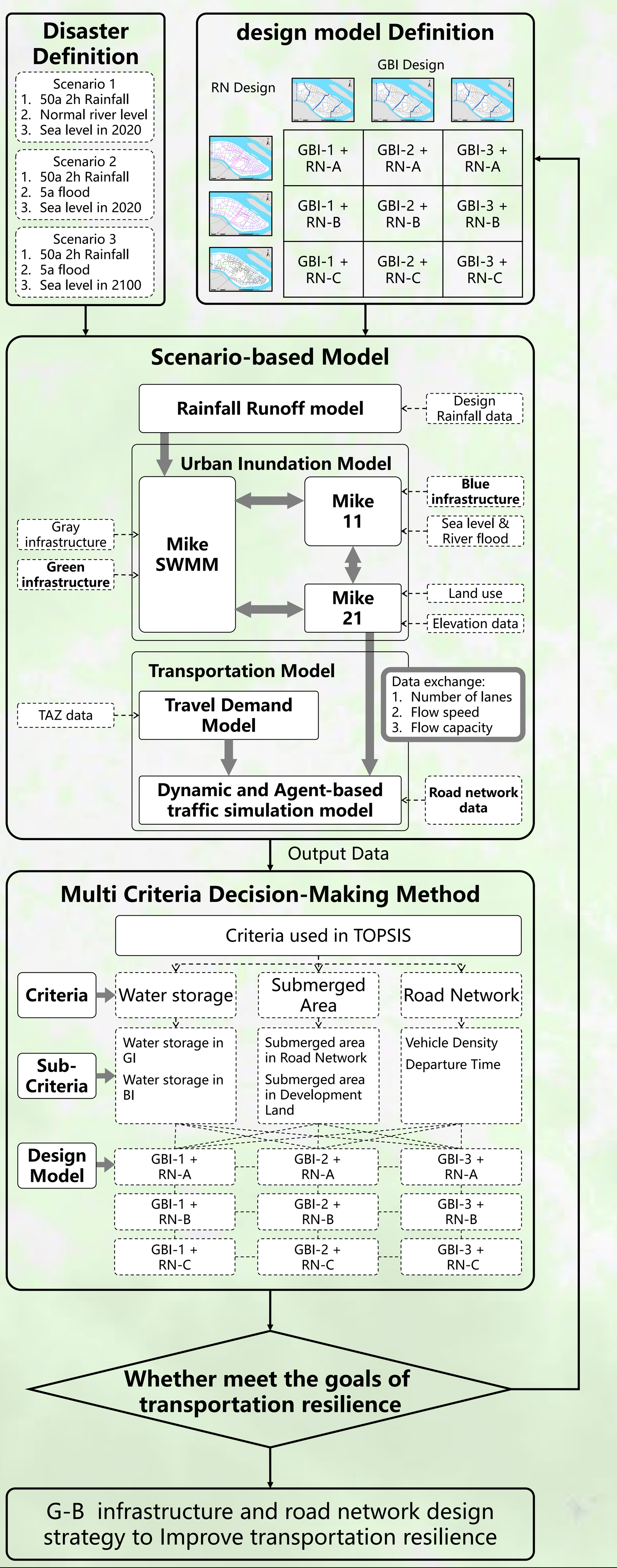
I. Introduction

- 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 design model, and disaster management to deal with coastal hazards, such as **urban flooding**.
- **Infrastructure Planning and Design** served as a key component in improving **resilience performance** in GBA.
- Policy makers and urban planners need **quantitative method** to assess the **transportation resilience performance** and identify the optimal design model.

Research question:

Which design strategy of Green-Blue infrastructure and road network can improve transportation resilience in GBA ?

II. Methodology



III. Scenario-based Model Simulation

• Disaster Definition

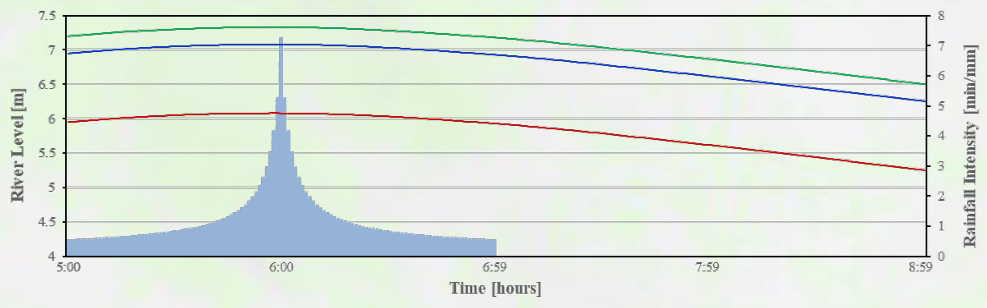


Figure 1 50-year rainfall and water level scenarios

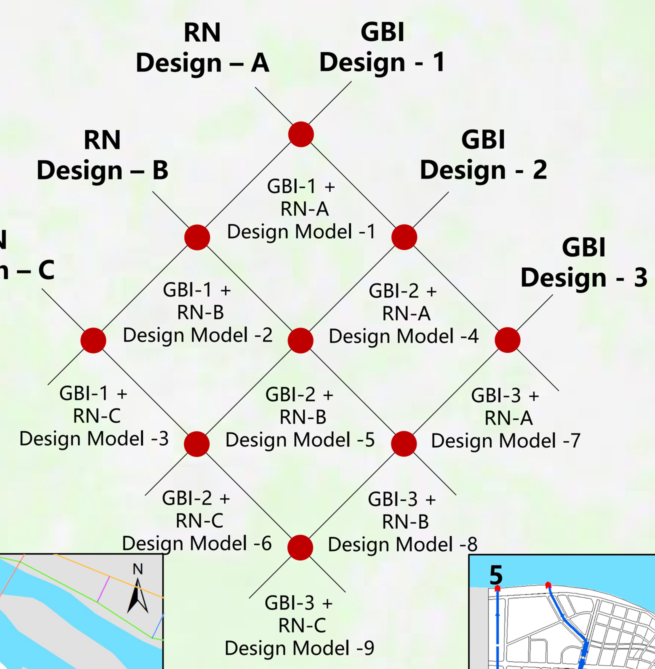
Scenario	rainfall	River flood	Sea Level Rise
Scenario1	50-year 2h design rainfall	Normal river level	Sea level in 2020
Scenario2	50-year 2h design rainfall	5-year flood	Sea level in 2020
Scenario3	50-year 2h design rainfall	5-year flood	Sea level in 2100

Table 1 definition of three different scenarios

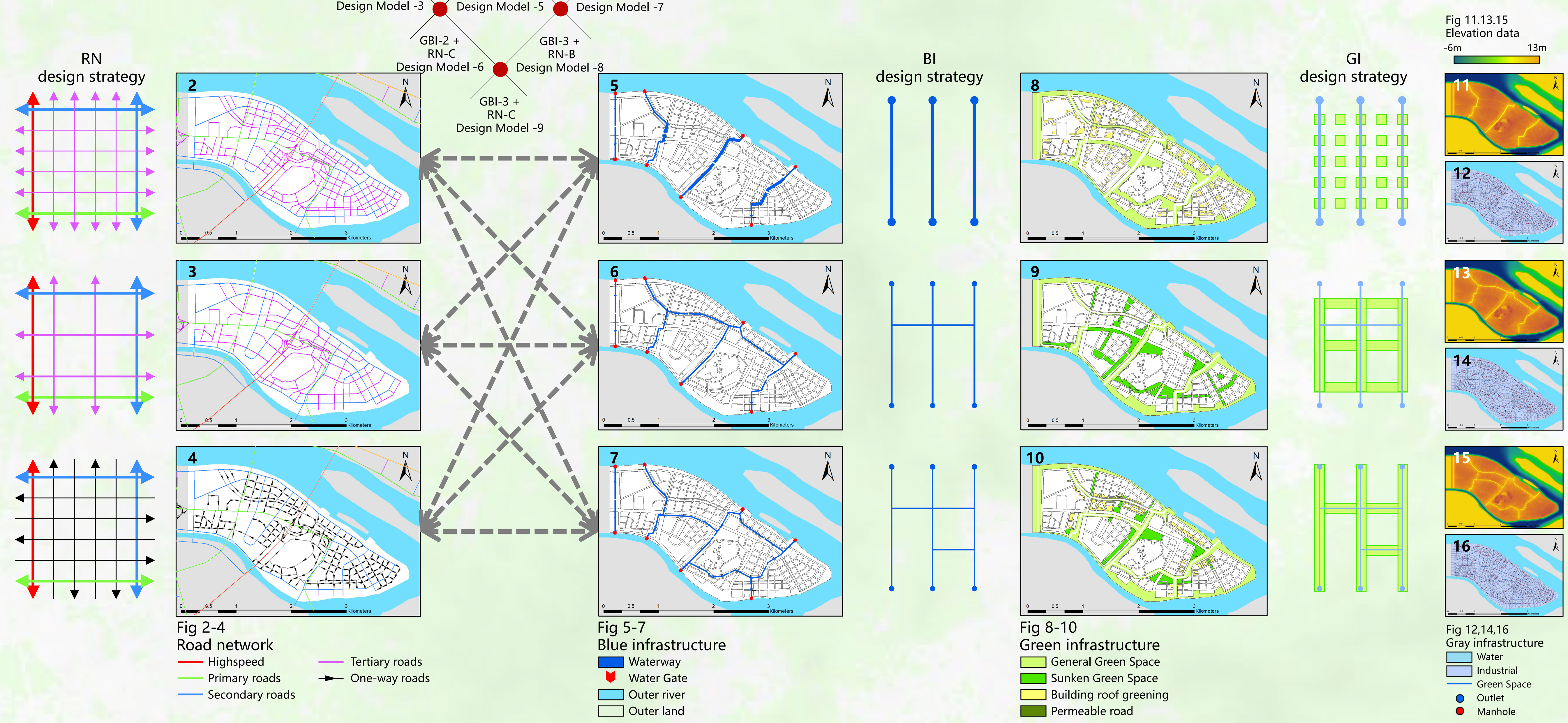
• Design Model Definition – with the same water space area, green space area and road land area.

9 different design models were generated by 3 Green-Blue Infrastructure (GBI) Designs & 3 Road Network (RN) Designs.

High density dual network	**Road Network Design – A**
Low density dual network	**Road Network Design – B**
High density single network	**Road Network Design – C**



Green-Blue Infrastructure Design - 1	The BI was designed as 3 individual parts, which connect 2 outlets with widest waterway,	LID projects was evenly distributed in area	The Gray infrastructure was designed to meet Specification for Urban Drainage Engineering Planning
Green-Blue Infrastructure Design - 2	The BI was designed as a tree structure, which the main waterway is in the middle of island,	LID projects was designed as link to connect different waterways.	
Green-Blue Infrastructure Design - 3	The BI was designed as single loop structure, which narrow waterway to connect the 6 outlets	LID projects was designed in the buffer of waterway	The elevation was designed based on the green-blue infrastructure.



IV. Result

• TOPSIS – Multi Criteria decision analysis

Using TOPSIS to calculate the score (best distance) based on 3 criteria from scenario simulation, design model – 7 get the best score, design model -8 & -9 get better score.

It means that Blue-Green infrastructure design is more important than road network design to improve urban flood resilience, and connectivity in waterway and redundancy in green space near to waterway is useful.

	Design model -1	Design model - 2	Design model - 3	Design model - 4	Design model - 5	Design model - 6	Design model – 7	Design model - 8	Design model - 9
	GBI-1 + RN-A	GBI-1 + RN-B	GBI-1 + RN-C	GBI-2 + RN-A	GBI-2 + RN-B	GBI-2 + RN-C	GBI-3 + RN-A	GBI-3 + RN-B	GBI-3 + RN-C
rank	7	9	8	4	6	5	1	3	2

• Urban inundation model - Water storage in Green Infrastructure & Submerged area in Road Network

Green-Blue infrastructure Design – 3 can retain more exceed rain water than other designs.

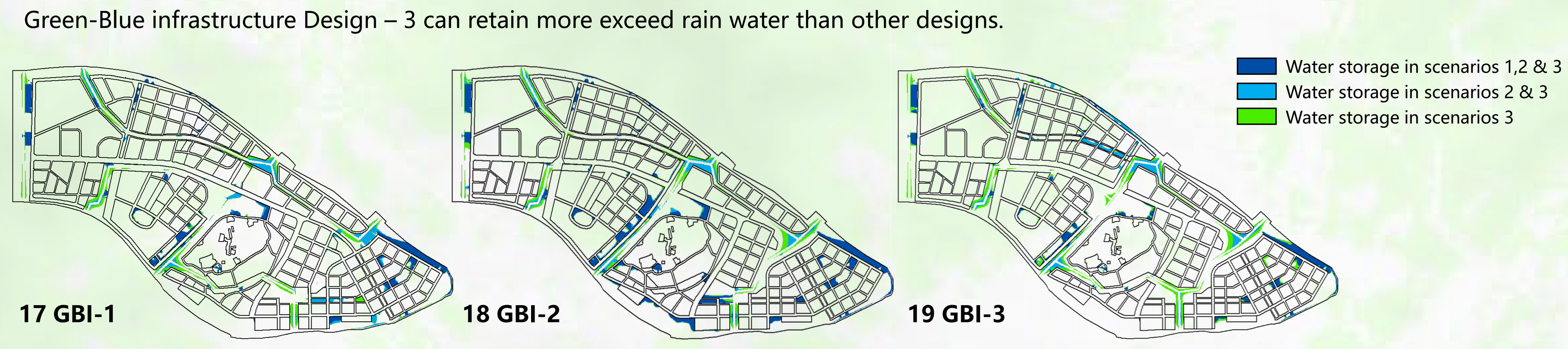


Figure 17-19 Water storage distribution in Green Infrastructure in GBI Design – 1, GBI Design – 2 & GBI Design – 3.

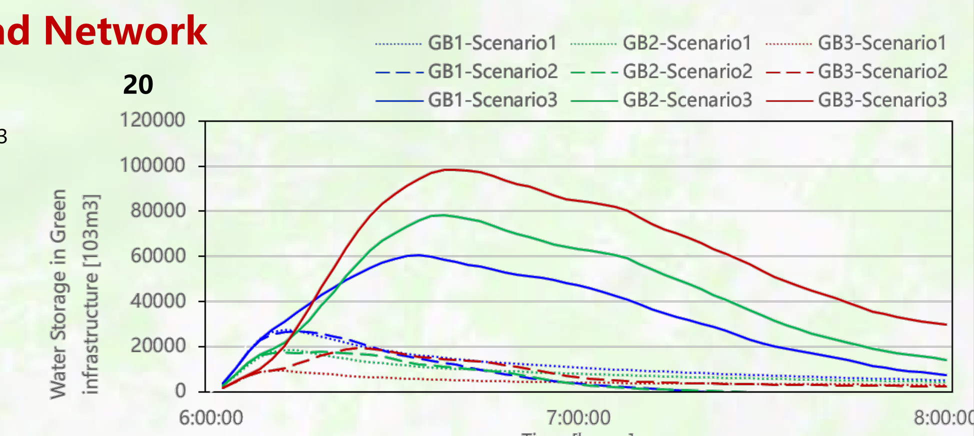


Figure 20 Water storage variation during rainfall in Green infrastructure

Green-Blue infrastructure Design – 3 can protect more road network than other designs

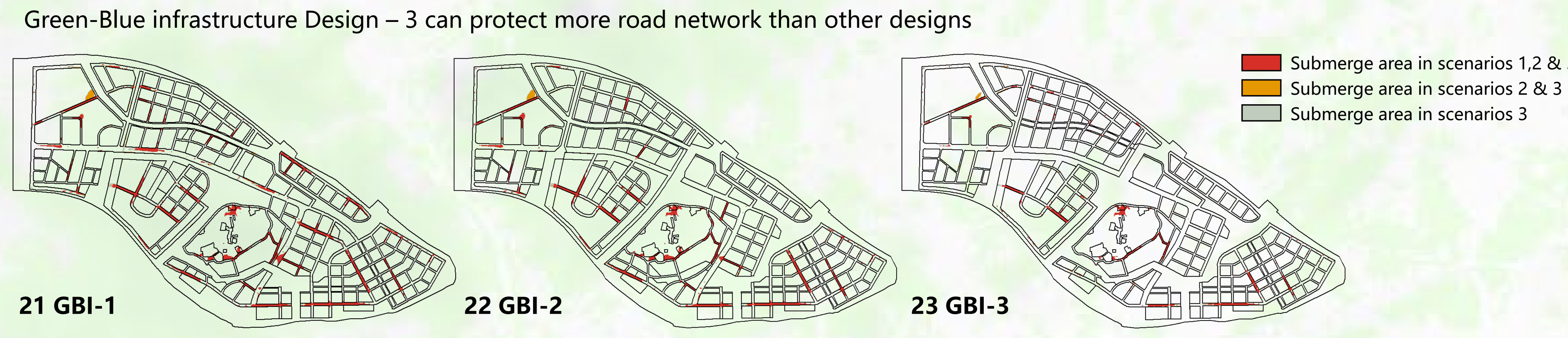


Figure 21-23 Submerge area distribution in Green Infrastructure in GBI Design – 1, GBI Design – 2 & GBI Design – 3.

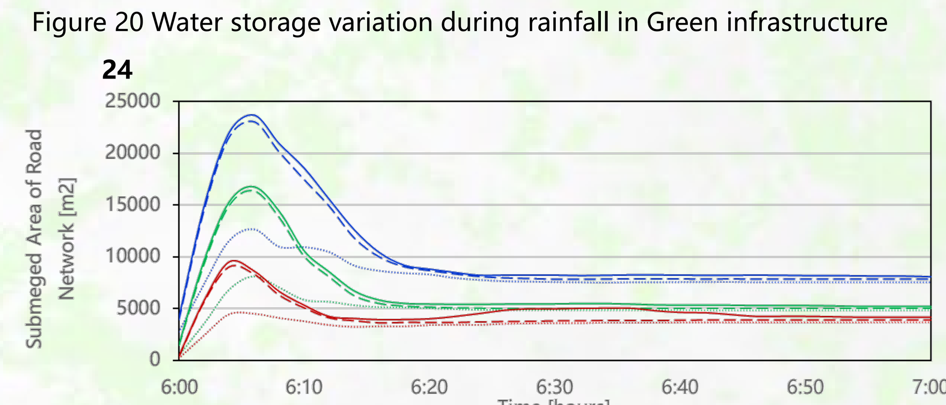


Figure 24 Submerge area variation during rainfall in Green infrastructure

• Road Network performance - Vehicle density & Departure time

While facing a heavy rainfall, people would try to **re-route** their path or **re-schedule** their departure time when the road is submerged by exceed rainwater.
Therefore, the **vehicle density** and **departure time** were calculated based on simulation result to evaluate the road network performance.
High density network and single direction network show similar better performance result than low density network.

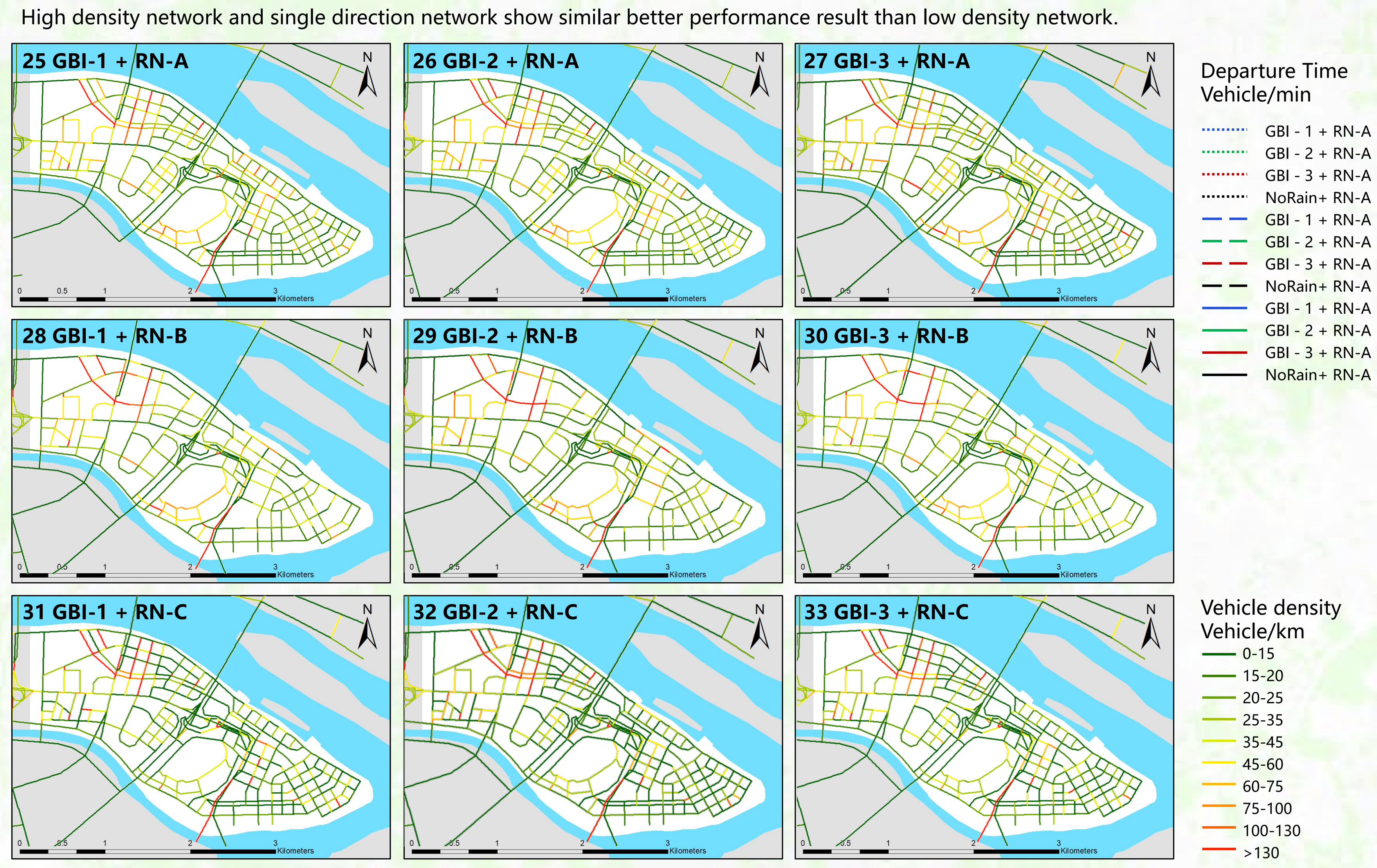


Figure 25-33 Vehicle densities distribution in 9 Design model3 in Scenario3. .

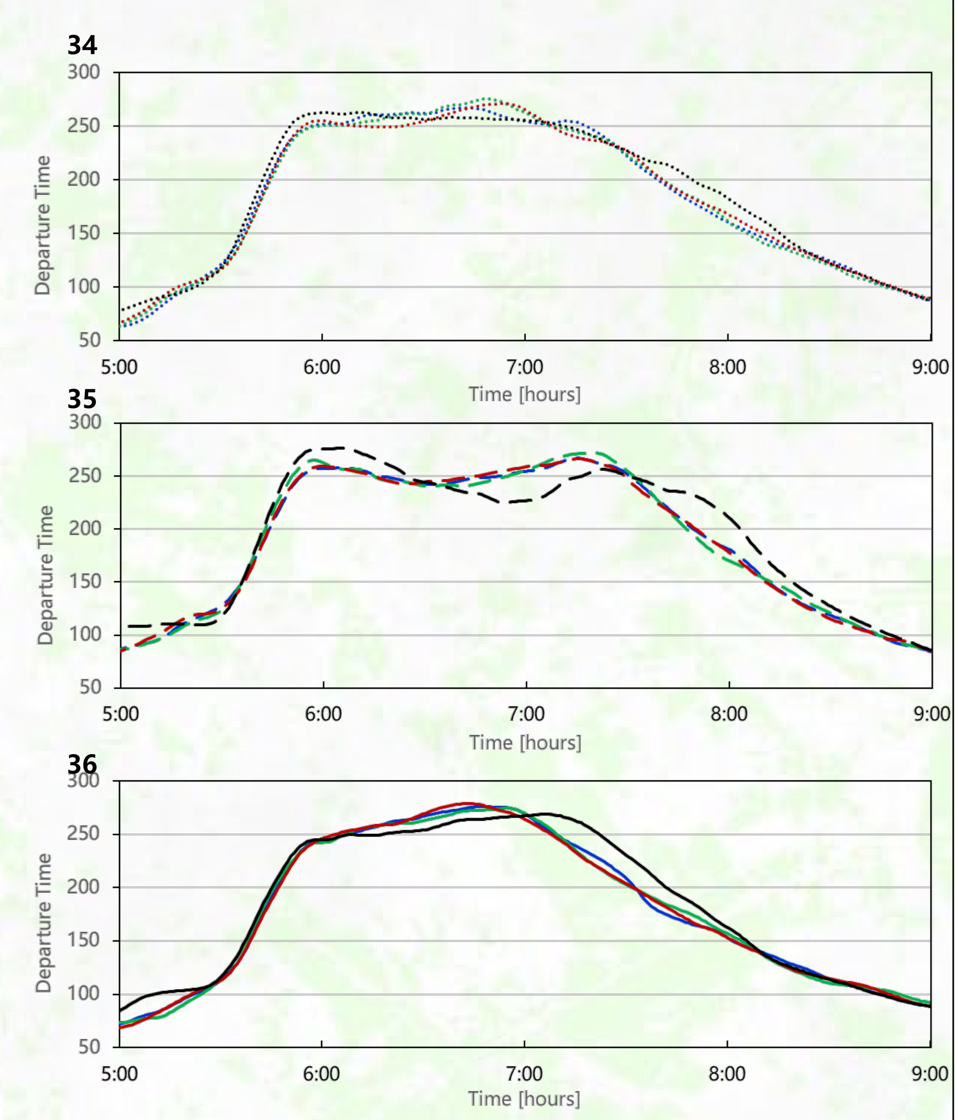


Figure 34-36 Departure time during rainfall in Scenario 3.

V. Conclusion

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

Scenario simulation of Urban infrastructure can help urban planners understand the pros and cons in various design strategies.

1. **In Blue infrastructure Design, with the same water space area,** the connectivity of urban waterway inside system is the key factor in Blue infrastructure resilience design.
2. **In Green infrastructure Design, with the same green space area,** the location of redundancy space is useful if it next to the waterway downstream or confluence section.
3. **In Road network Design,. with the same road land area,** the road network resilience can be strengthened by improving road density or using single direction control measure.

VI. Future work

Multi modal transportation model

- Expand single modal transportation model to multi modal transportation model to evaluate the impact of water disaster.

Computational Efficiency

- Use more GPUs to accelerate computing with parallel processing.

Expand the research area to the whole GBA

- To evaluate the resilience performance while facing extremely water disaster of current infrastructure system in the whole GBA.

VII. Acknowledgement

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