

Cooling Capacity of Urban Vegetation with Diverse Densities and Spatial Patterns in Tropical Cities

— An experience from Singapore

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KEYWORDS: Urban vegetation, Cooling capacity, Greenery spatial pattern, Urban greenery design guidance, Tropical cities

BACKGROUND

In highly urbanized and well-established urban environment, the integration of urban vegetation serves as a more feasible solution to alleviate UHI intensity.

Strategic planning on green areas and deliberate choice of plant are important to unleash the cooling capacity of urban vegetation and maximize its cooling effect in the various urban contexts.

RESEARCH GAP

Gap between theoretical results from urban climatology and urban design practice.

FINDINGS

1. Qualitative findings

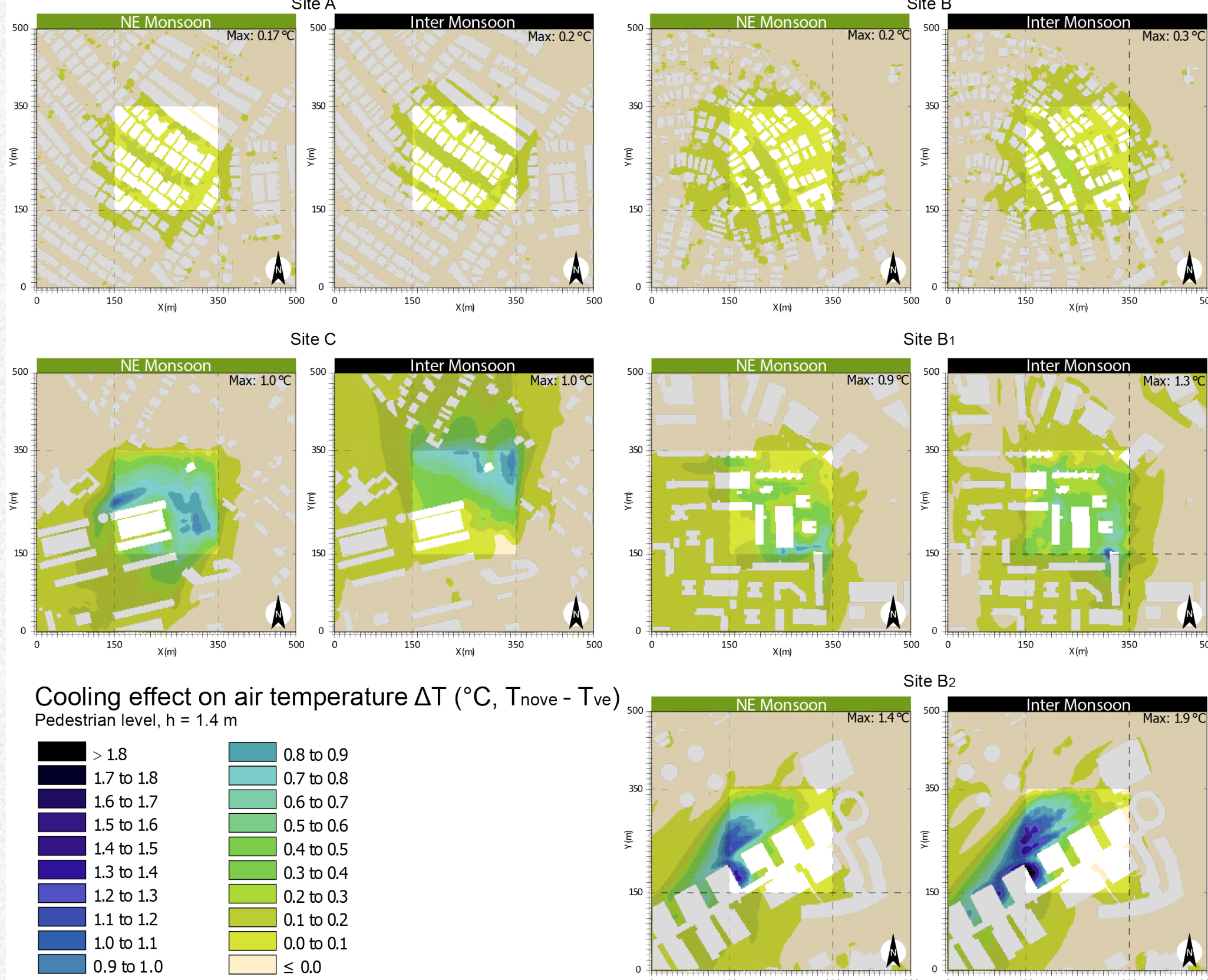


Fig 1 Spatial distribution of the cooling capacity (ΔT) during the maximum hour in NE monsoon season and inter-monsoon season.

2. Quantitative findings

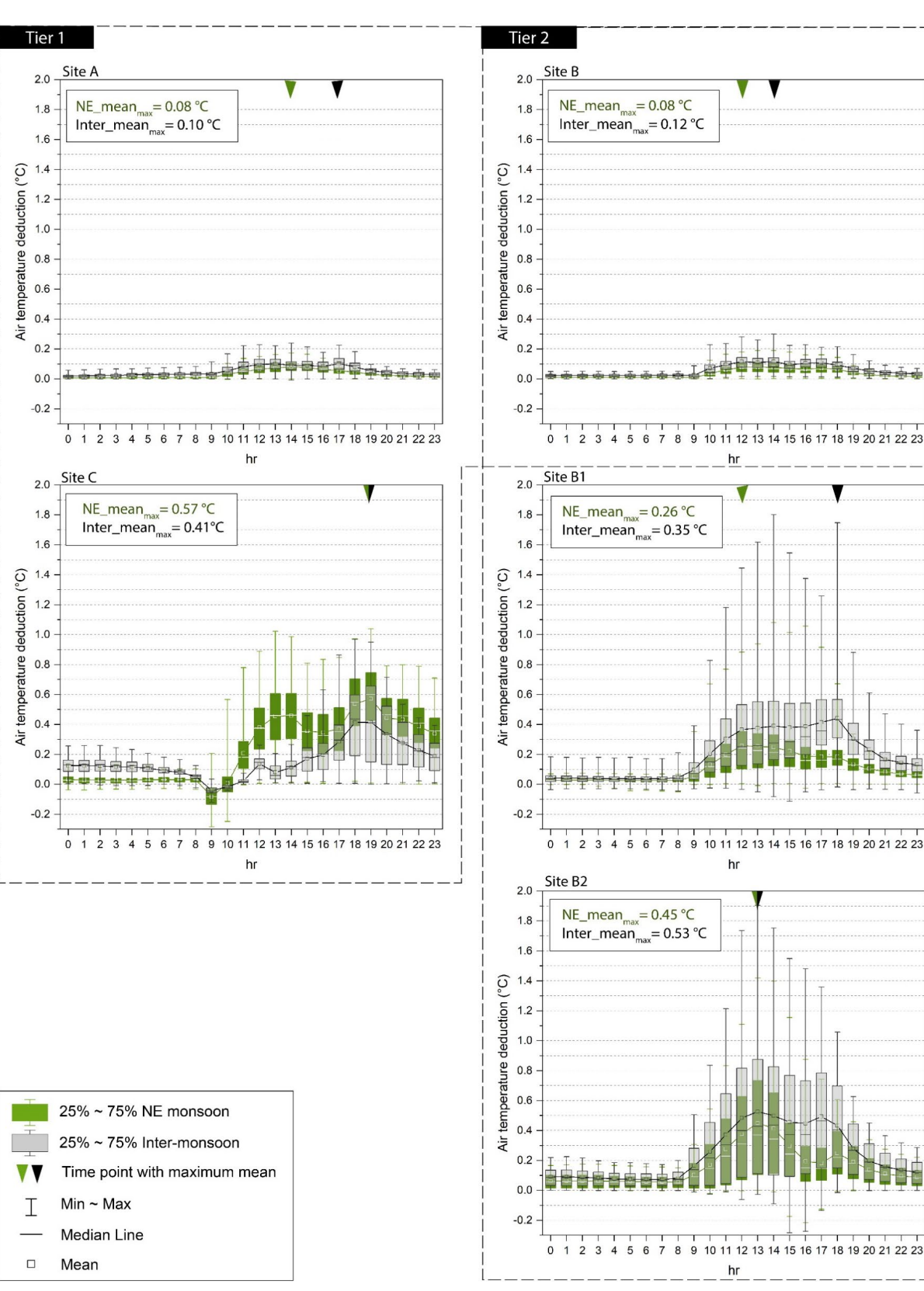


Fig 2 Daily profile and the spatially averaged value of air temperature deduction (ΔT) results in a 24h duration during NE monsoon season (green) and inter-monsoon season (grey) of 5 sites.

3. Urban design implementation

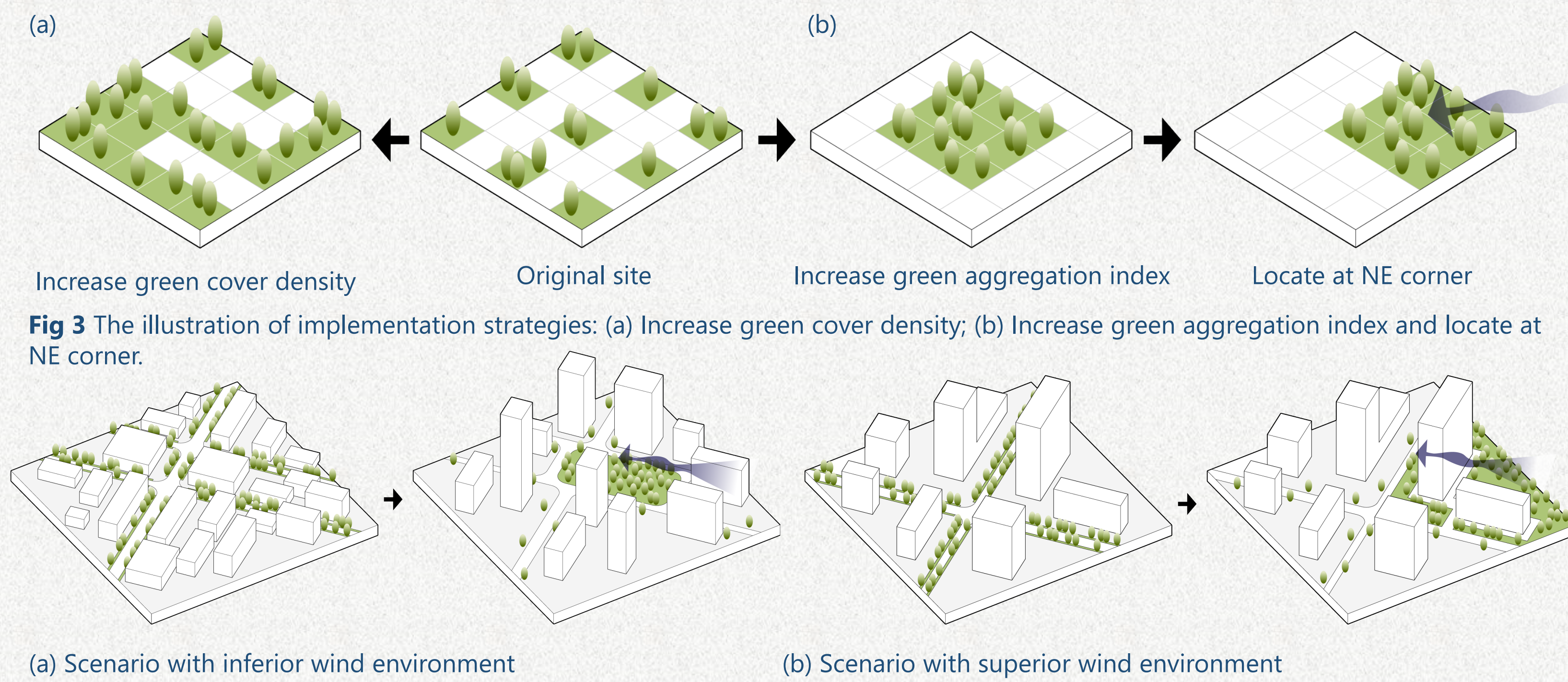


Fig 3 The illustration of implementation strategies: (a) Increase green cover density; (b) Increase green aggregation index and locate at NE corner.

CONCLUSIONS

- Higher green cover density and aggregation index enhance urban cooling capacity (Fig 1 & Fig 2).
- Strategic placement of aggregated greenery on windward corners maximizes cooling benefits of the site (Fig 1 & Fig 2).
- Site-specific implementation necessitates integrated of site context and climate conditions, particularly wind environment (Fig 4).

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(Weather data)

AIM

To examine the coupling effect of urban morphology and vegetation configurations on vegetation cooling capacity and correspondingly provide the better insights to implement vegetation into various urban contexts to optimize its cooling effect.

METHODS

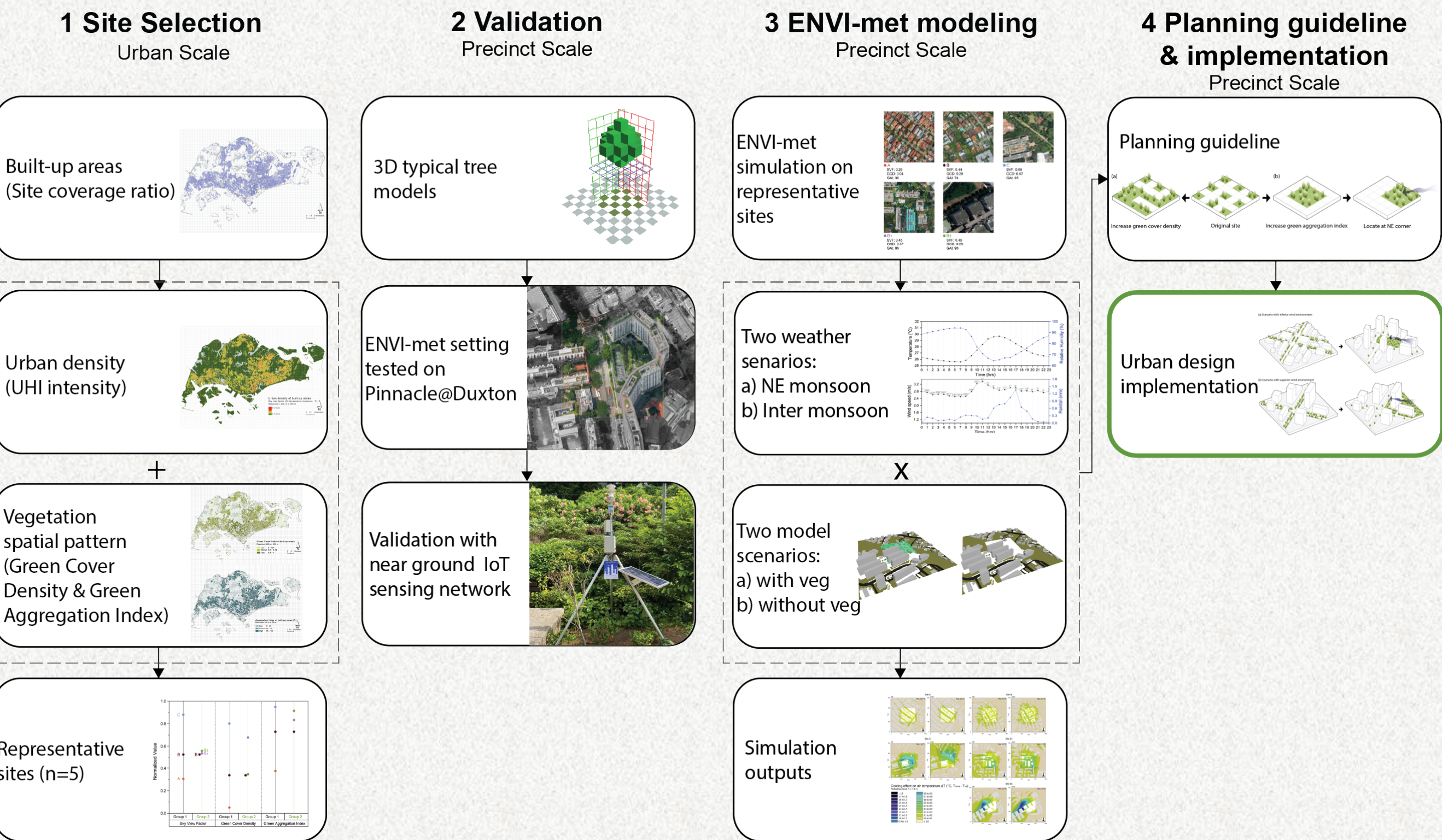


Fig 5 Research structure with four steps.

Specifically, research methods include mapping, field-measurement for validation, case study for implementation:

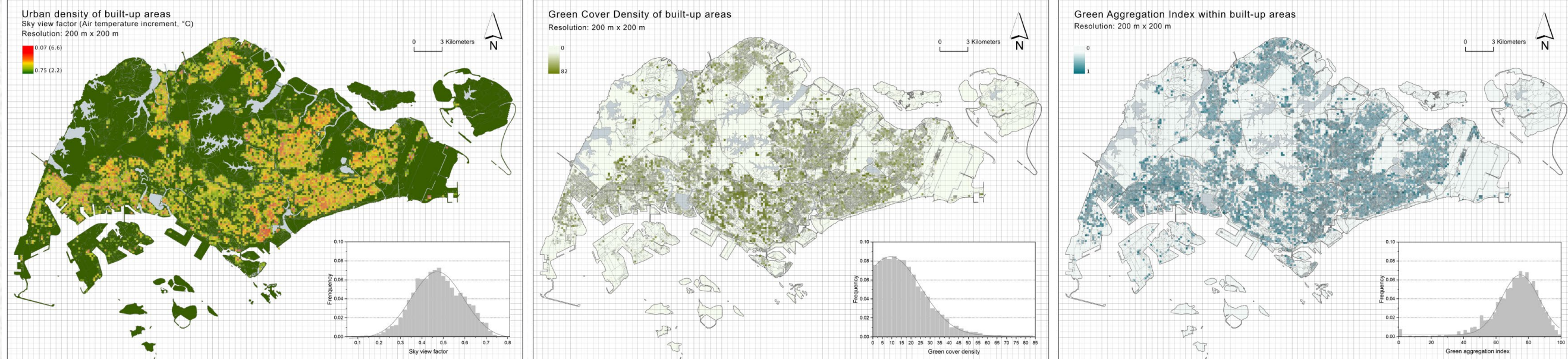


Fig 6 Mapping results on urban density, green cover density and green aggregation index.

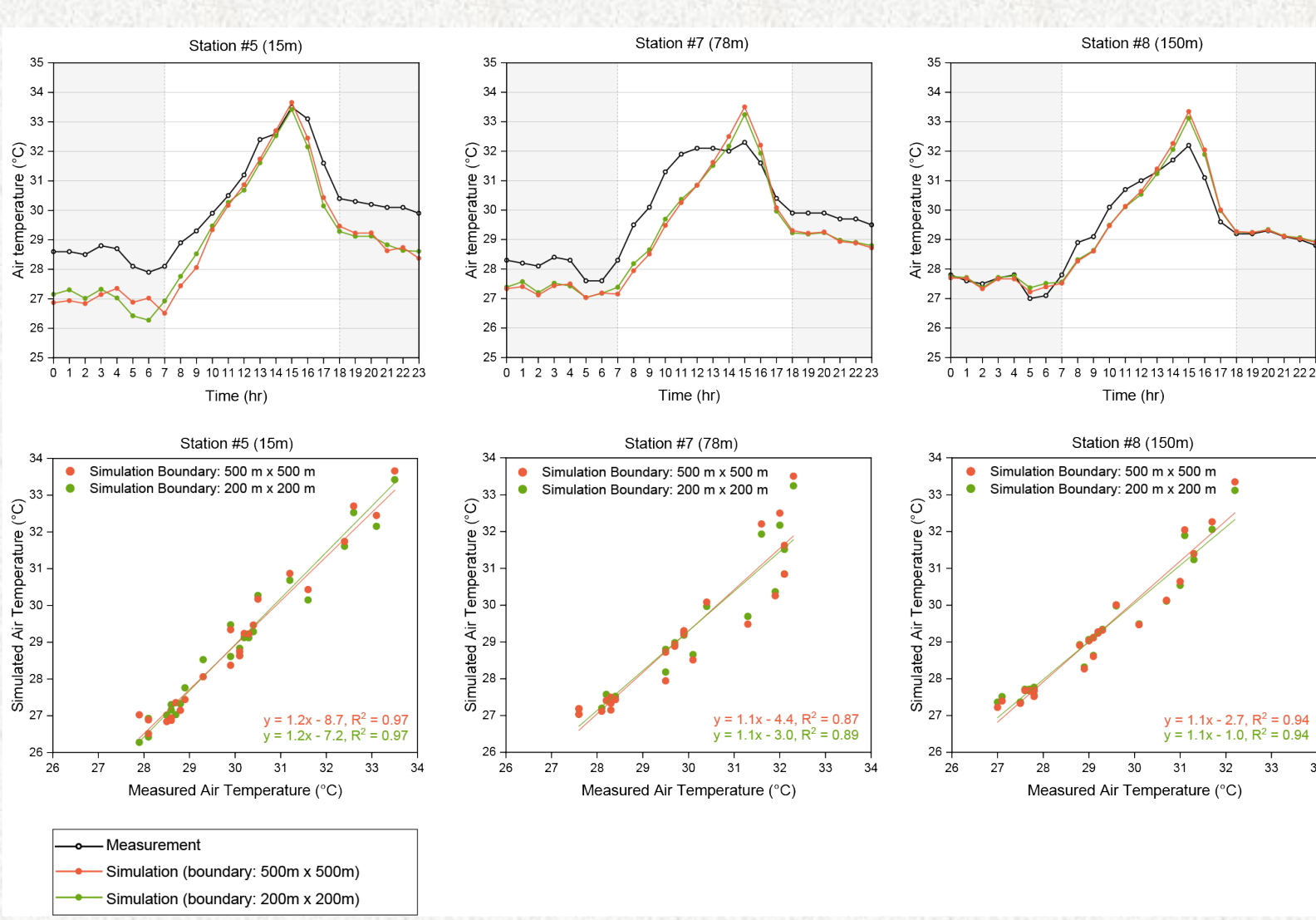


Fig 7 Simulated results and observed air temperature of stations.

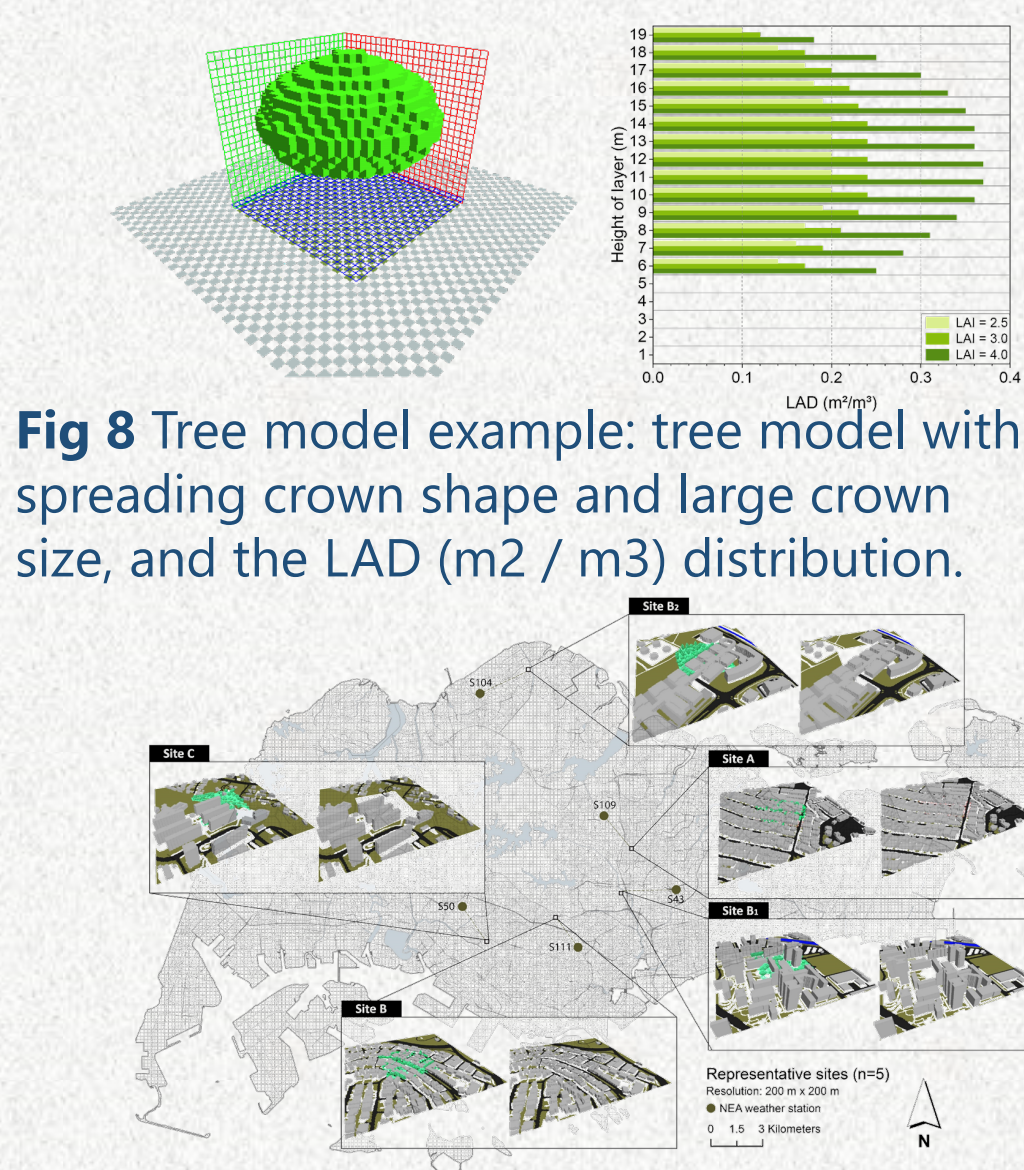


Fig 8 Tree model example: tree model with spreading crown shape and large crown size, and the LAD (m² / m³) distribution.

KEY DISCUSSION POINTS

- Scientific understandings on the impact of densities / spatial patterns of greenery, urban contexts, and background climate conditions on the cooling capacity of greenery.
- Planning strategies on the location and pattern of urban vegetation based on different urban context and wind environment.

Future applications

- Enhance data-driven model for mapping to identify vulnerable areas for targeted interventions in the future.
- Embrace nature-based solutions as a primary strategy against urban heat islands effect.
- Prioritize climate-conscious urban design, emphasizing the cooling potential of greenery for sustainable city development.

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