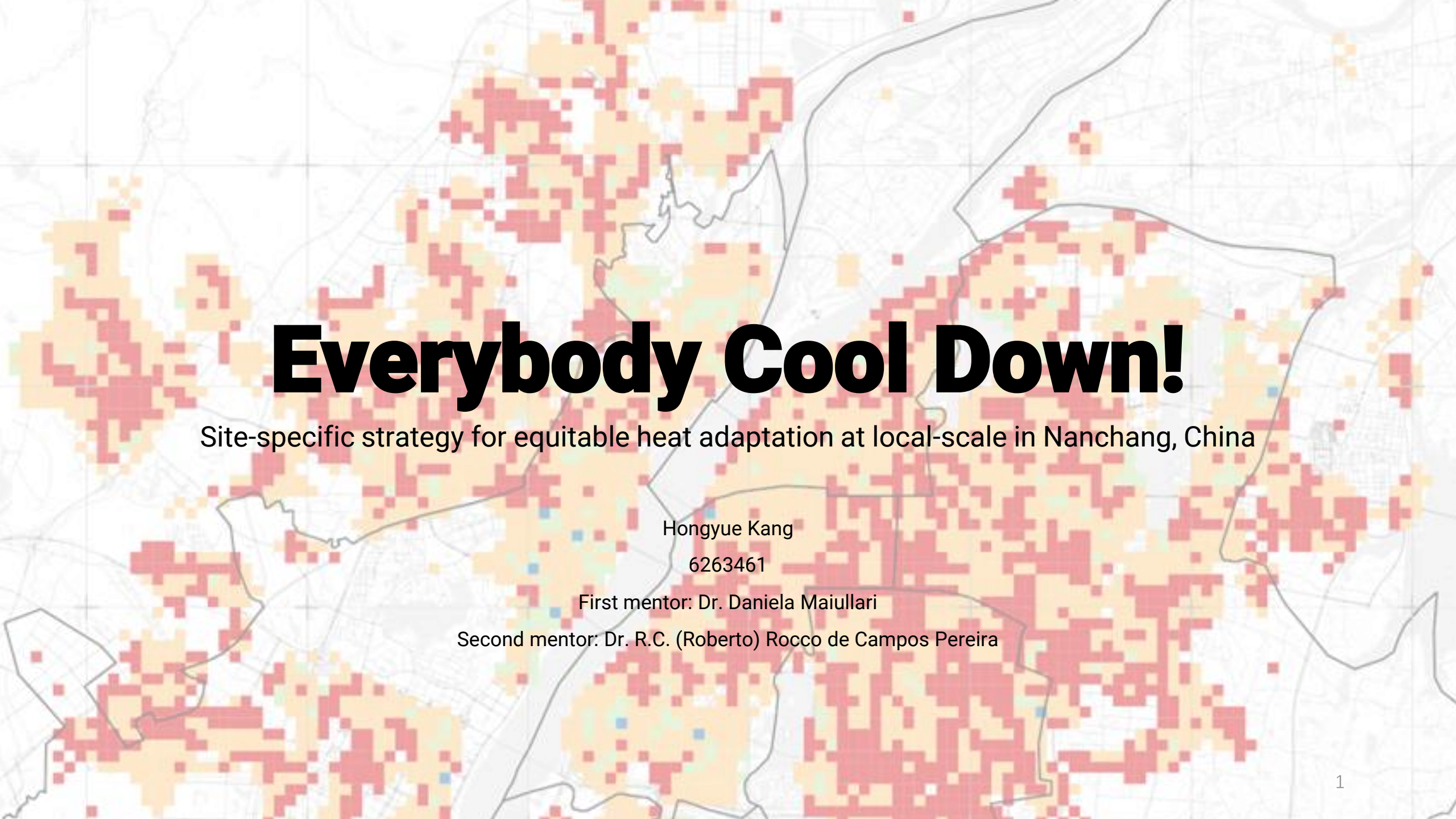


Everybody Cool Down!

Site-specific strategy for equitable heat adaptation at local-scale in Nanchang, China

Hongyue Kang

6263461

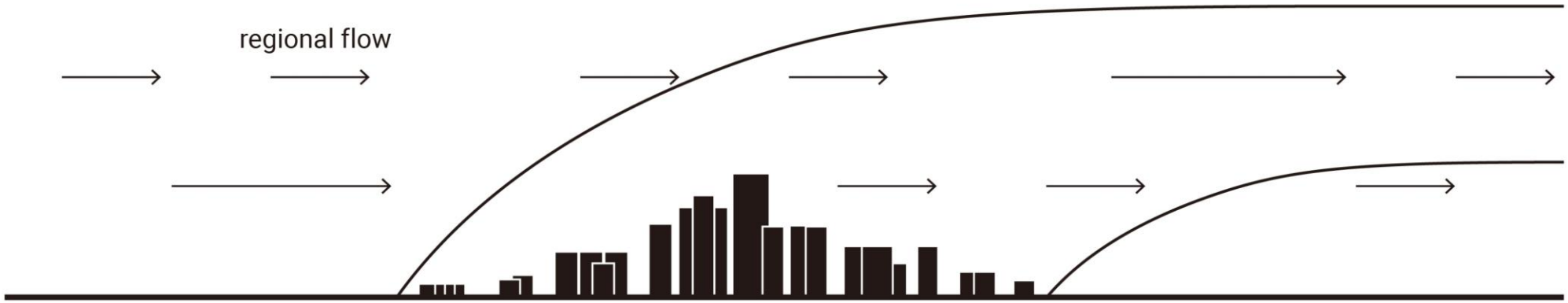
First mentor: Dr. Daniela Maiullari

Second mentor: Dr. R.C. (Roberto) Rocco de Campos Pereira

Content

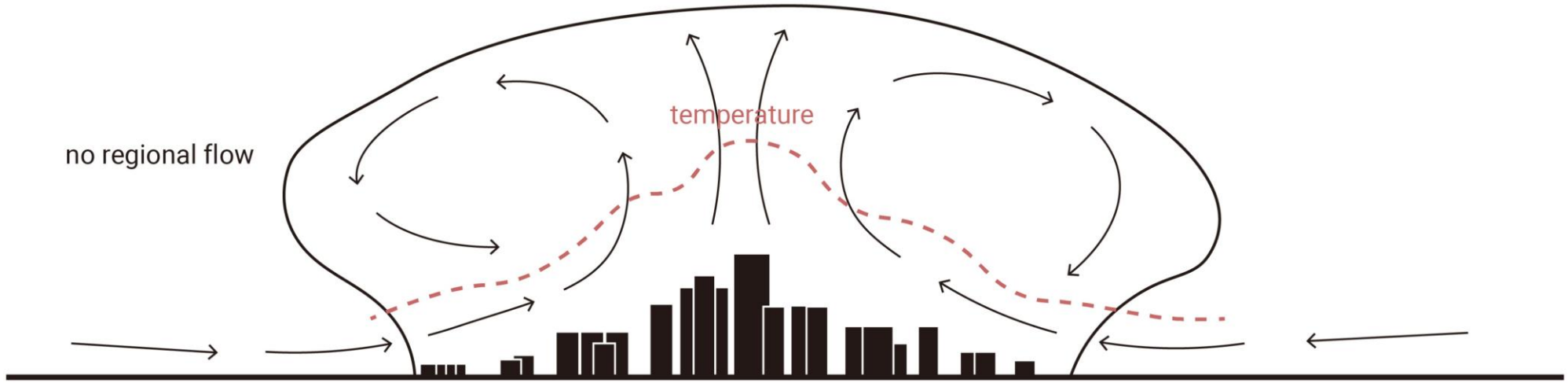
1. Background

Urban Heat Issue



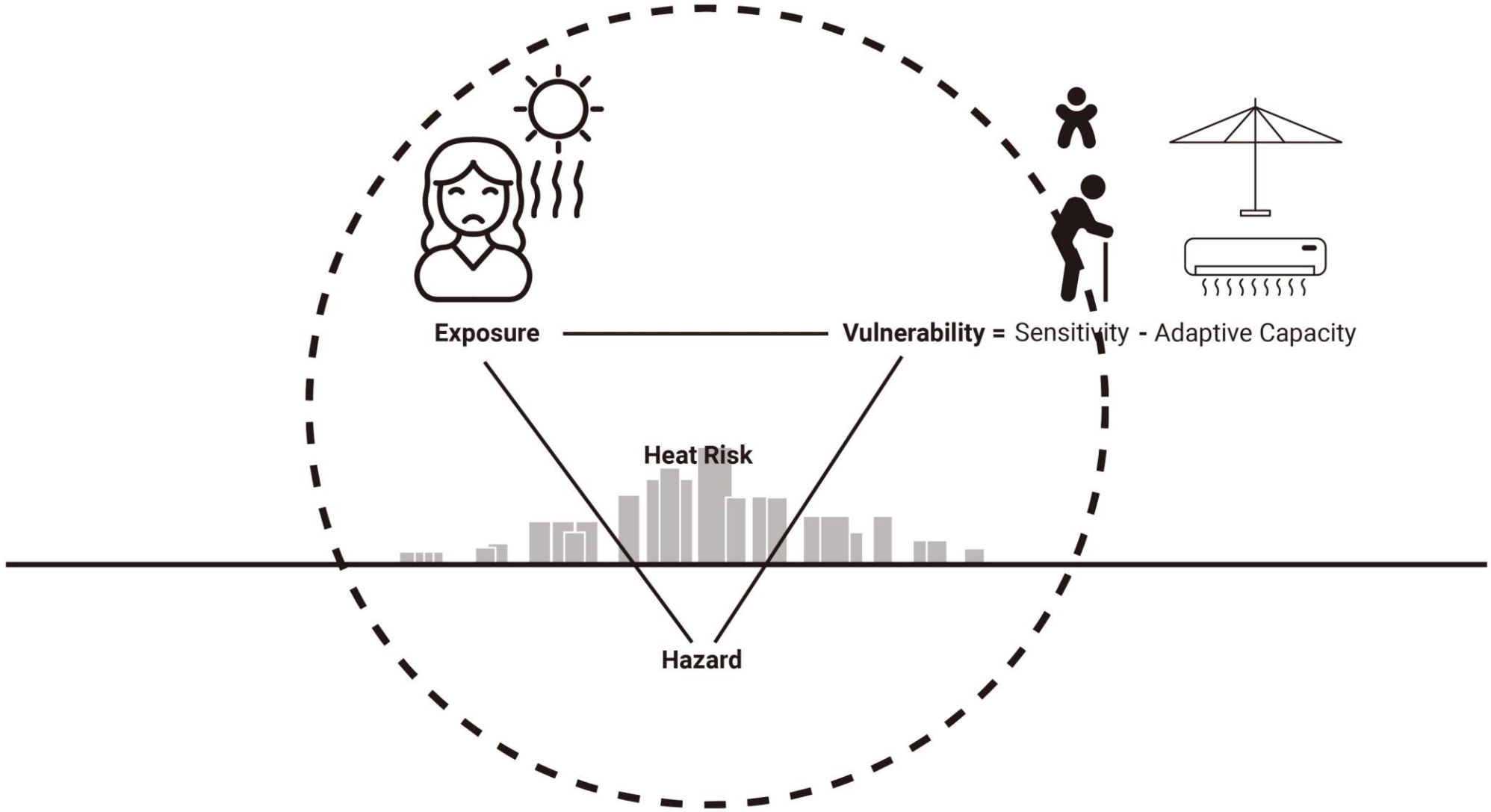
Influencing factors of urban heat: **macroclimate**

Urban Heat Issue



Influencing factors of urban heat: **Urban Heat Island**

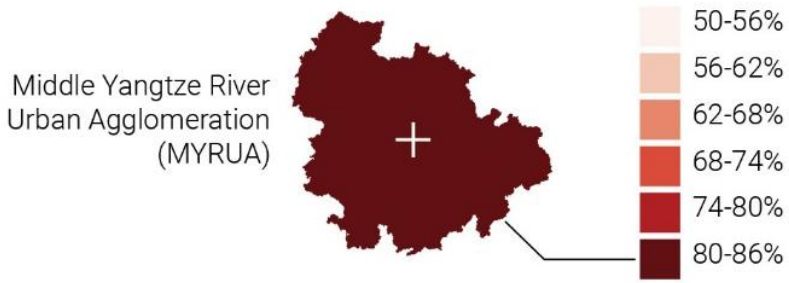
Urban Heat Issue

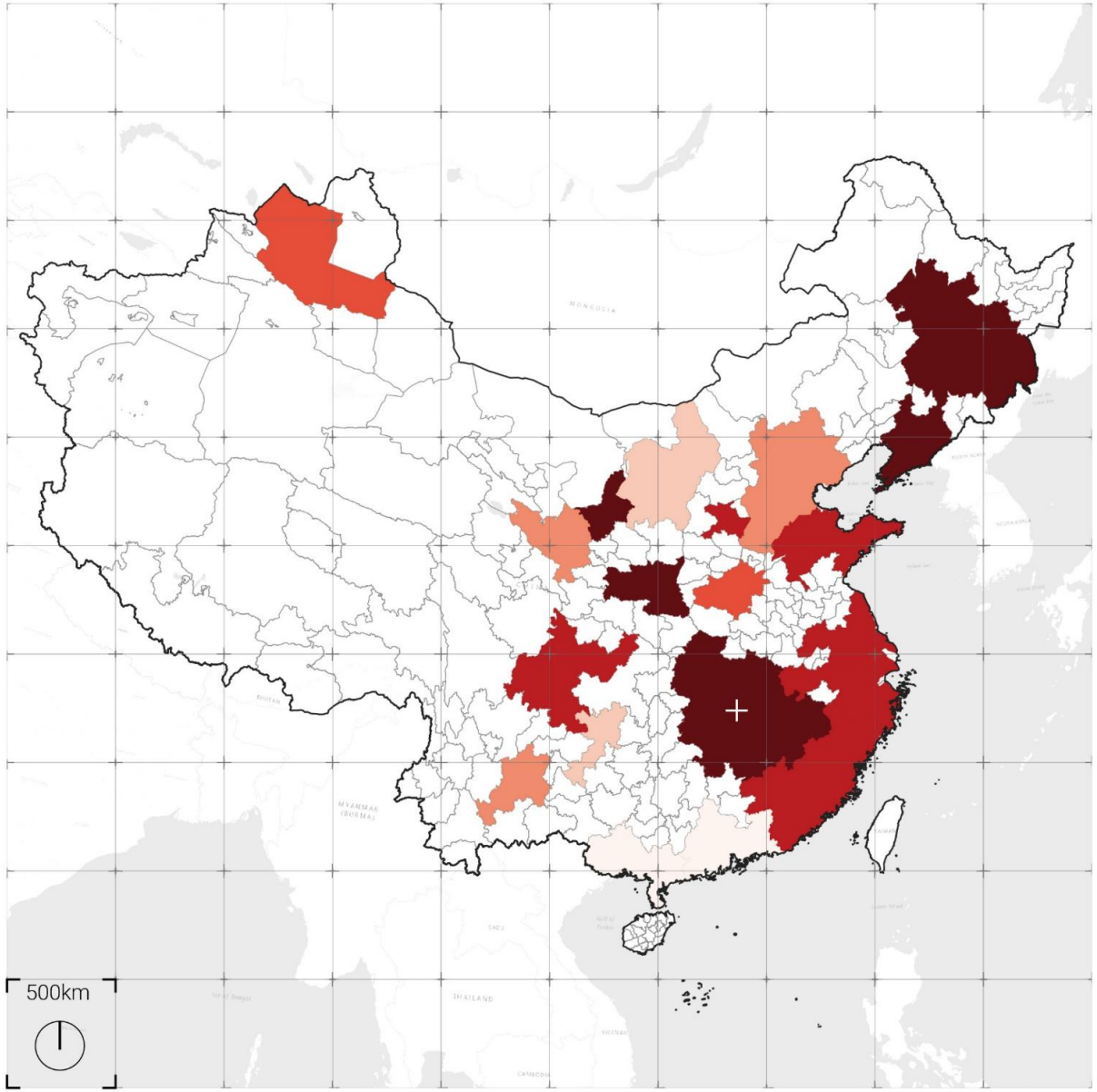


Urban Heat Issue

physiological equivalent temperature (PET)

China is getting hotter





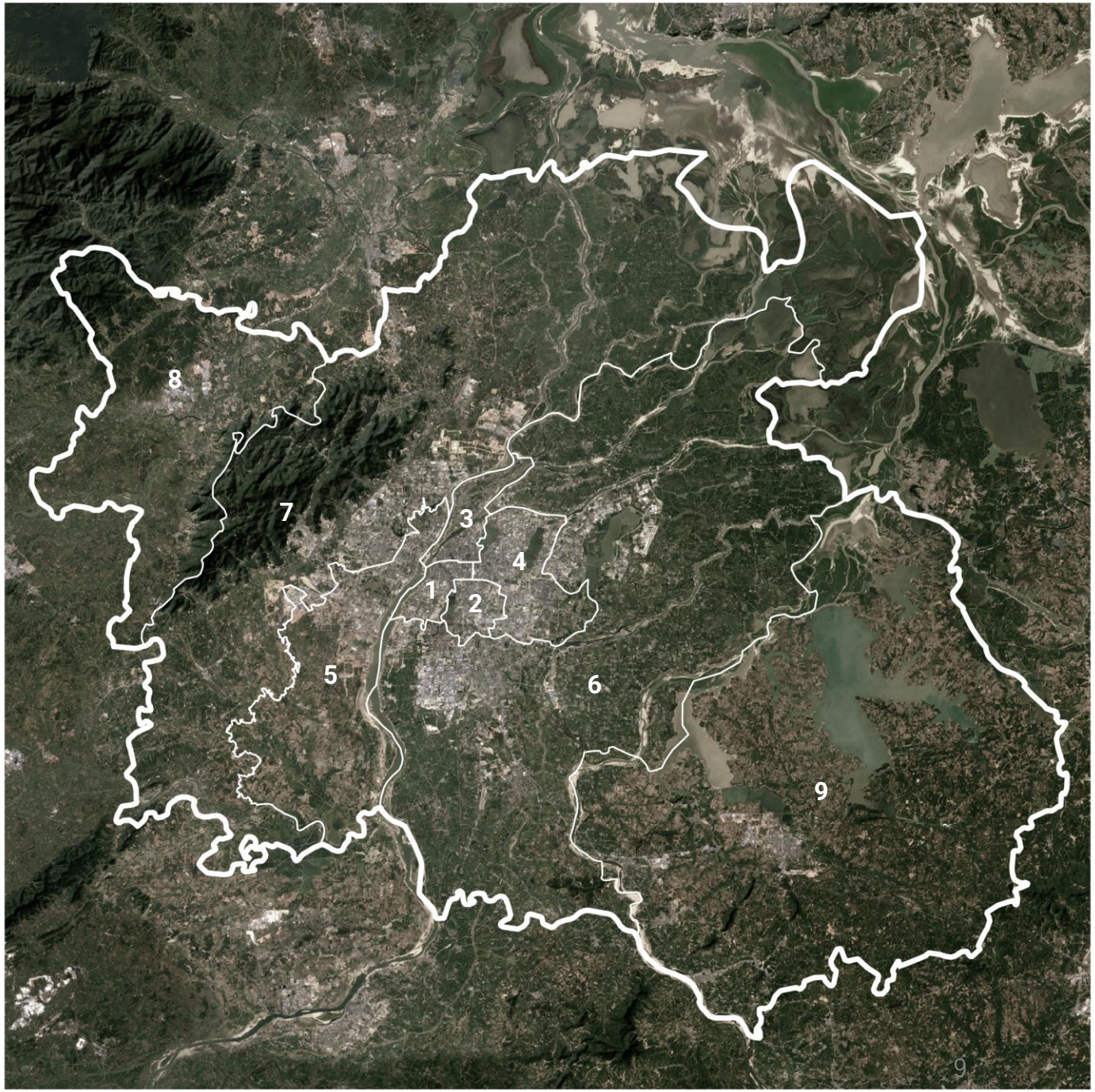
Mean Percentage Heat Island in Summer Daytime of Major Urban Agglomerations in China during 2000–2015

Redrawn by the author based on " Population exposure to extreme heat in China: Frequency, intensity, duration and temporal trends.," by Long Li, Yong Zha, 2020, Sustainable Cities and Society 60 (6), 2020,102282: ISSN 2210-6707. https://doi.org/10.1016/j.scs.2020.102282.

Nanchang

Basic Information of Nanchang

Nanchang is the capital city of Jiangxi province as well as a key central city in the MYR Urban Agglomeration. It has **7,194.98 ㎢** with the population of **6.67 million.**



Administrative District in Nanchang

By Author

0 10 20km N

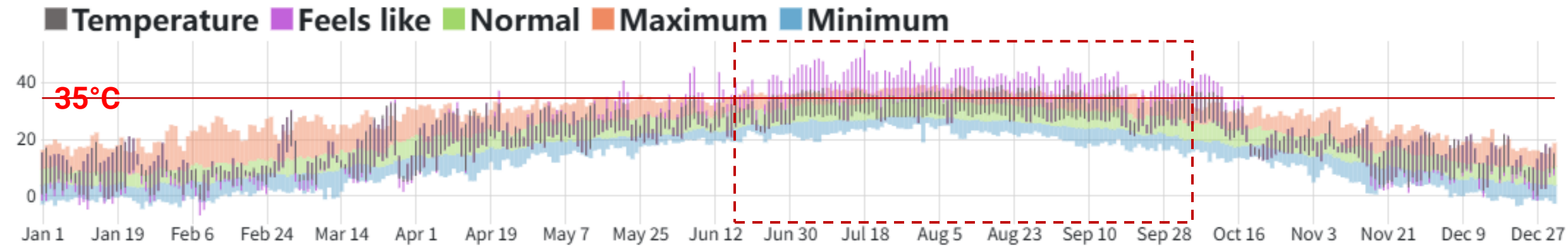
1 Xihu District
2 Qingyunpu District
3 Donghu District
4 Qingshanhu District
5 Honggutan District
6 Nanchang County
7 Xinjian District
8 Anyi County
9 Jinxian County

Nanchang-the “Furnace City”

Macro-climate Characteristic

Nanchang’s macroclimate: **sub-tropical monsoonal climate**
Climate characteristic: **hot, humid summers** with abundant rainfall and mild winters, driven by strong seasonal monsoon circulation.

In 2025, Nanchang has **more than 78 high-temperature days (daily maximum ≥35°C)**, surpassed the **previous record of 59 days set in 2022**, making 2025 the year with the highest number of high-temperature days **since meteorological records began in 1951** (China Meteorological News, 2025)



Climate statistics of Nanchang in 2025

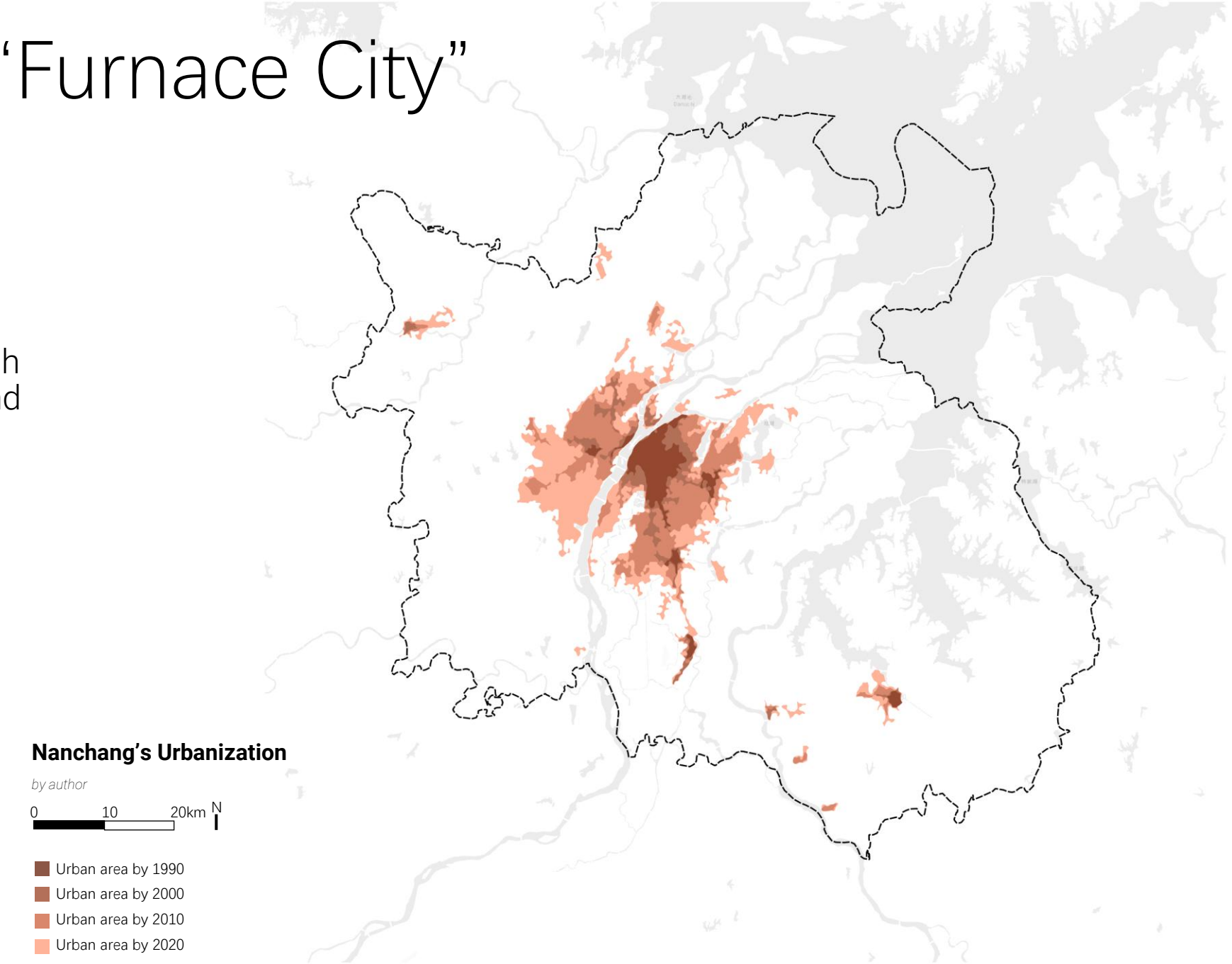
Visual Crossing Corporation. (2025). Visual Crossing Weather (Nanchang, July 2025) [Data set]. Retrieved from https://www.visualcrossing.com/

Nanchang-the “Furnace City”

Fast Urbanization

During the past 30 years, a lot of areas in Nanchang has been through a transition from traditional farmland towards urban area.

Urban area in Nanchang had increased from **4,830 ha** to **12,090 ha** (**150.31% increase**) between **2000 and 2013**.



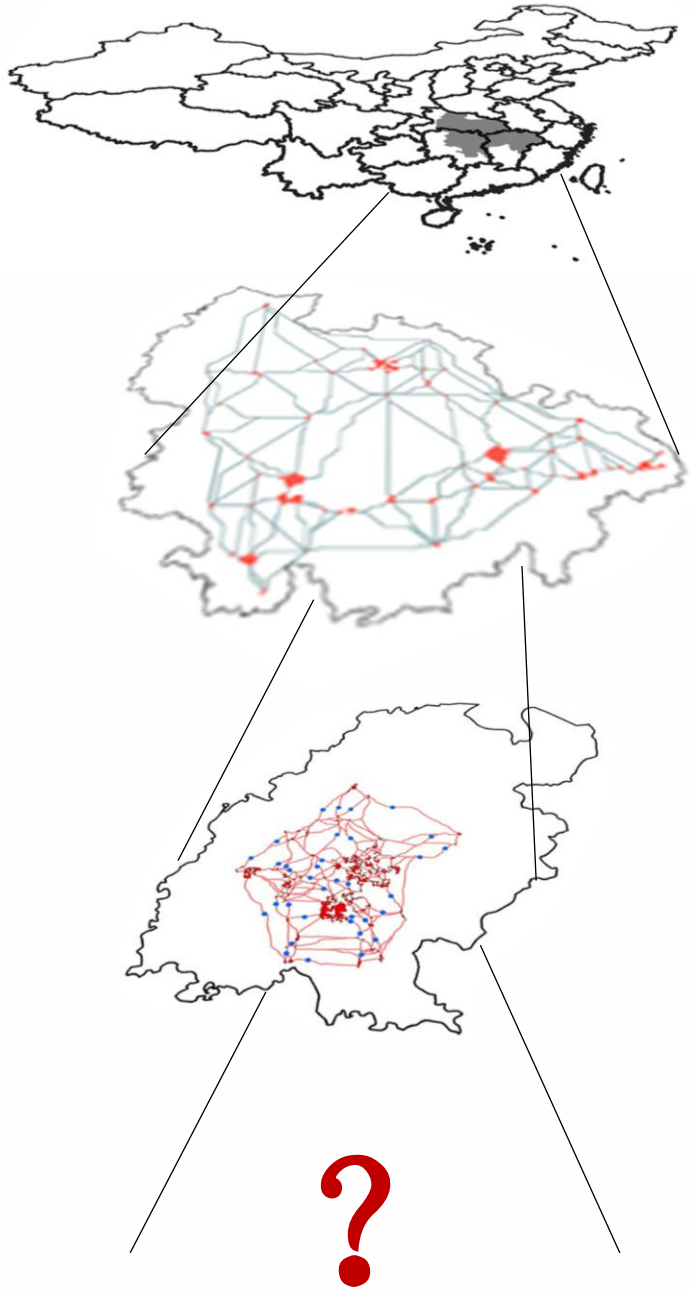
Current adaptation

Nation scale
2013----*National Climate change Adaptation Strategy*
2022----*Climate Change Adaptation Strategy 2035*

Regional scale
UHI network in MYR urban agglomeration (Fang et al, 2023)

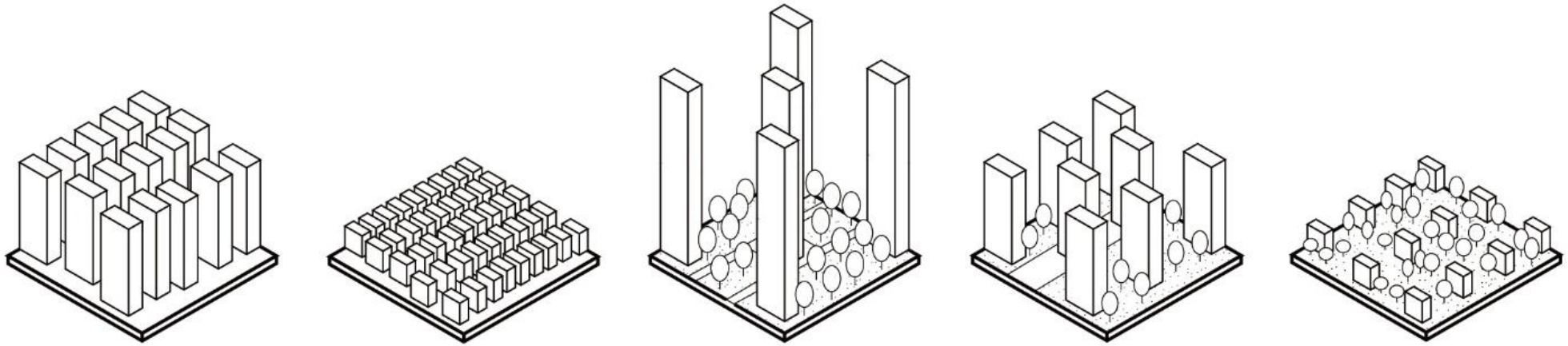
City scale
UHI network (Lan et al, 2025) / Nested cooling island network (Wang et al, 2025)

Local scale
?



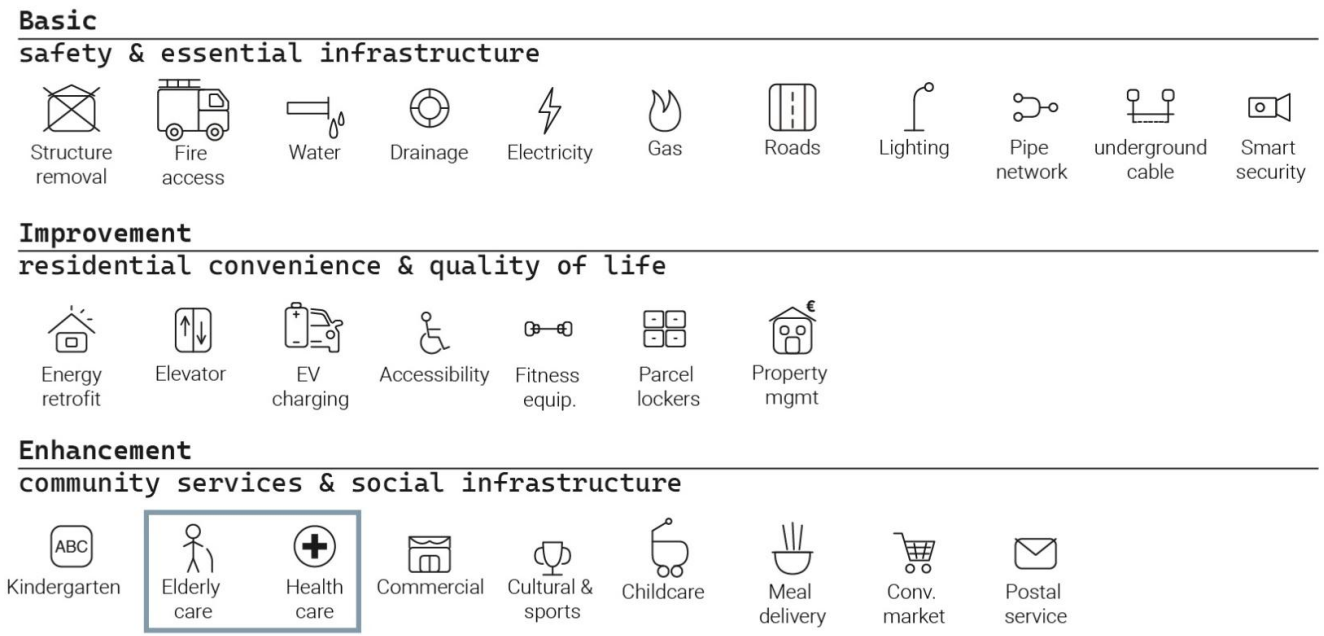
2. Inequity in Heat Adaptation

Distributional inequity

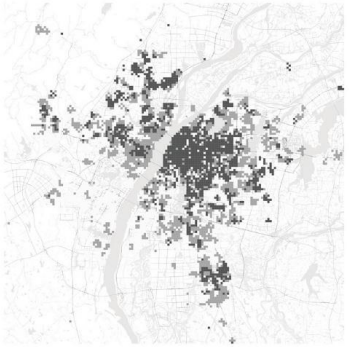


Compact midrise | Compact low-rise | Open high-rise | Open midrise | Open low-rise

Procedural Inequity



selection based on building age



Old renovation process

strategy

Implementation plan
Implementation Plan for the Renovation of Old Urban Residential Communities in Nanchang City, 2022

Design by expert

Technical guidance
Technical Guidelines for the Renovation of Older Residential Communities in Jiangxi Province

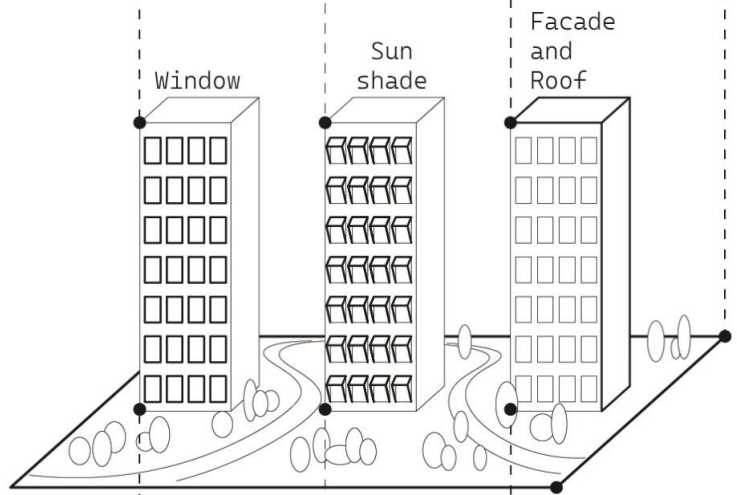
Acceptance and evaluation

Evaluation Indicators for the Renovation of Old Residential Communities

Green building codes

Building Energy Efficiency Retrofits

Landscape Renovation



Green building codes

"Energy Efficiency Design Standards for Residential Buildings in Jiangxi Province" (DBJ/T 36-024)

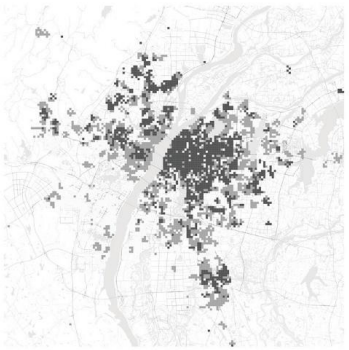
"Energy Efficiency Design Standards for Public Buildings" (GB 50189)

Technical Specifications for Energy-Efficient Retrofits of Existing Residential Buildings (JGJ/T129)

Estimation

No documents on thermal environment performace estimation

selection based on building age



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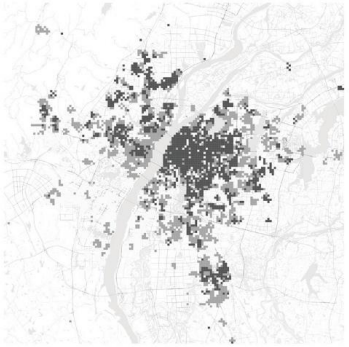
selection based on building age



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Stakeholder during the Process

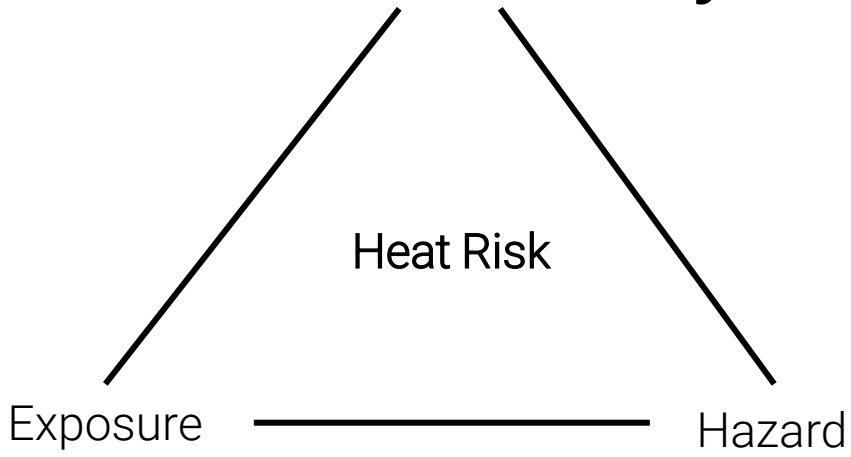
Research Question:

How can site-specific design reduce heat risk at local scale, promoting equity in urban heat adaptation in Nanchang, China?

3. Strategy: Vulnerability map

Vulnerability = Sensitivity – Adaptive Capacity

(IPCC, 2014; 2022)



Vulnerability = Sensitivity – Adaptive Capacity

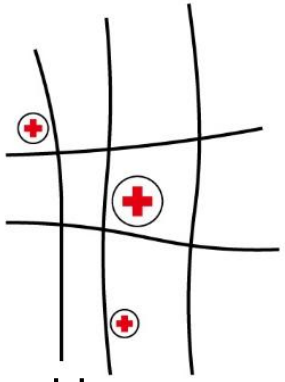
(IPCC, 2014; 2022)

Age
(14-, 65+)

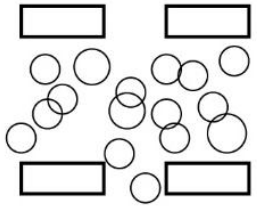
RMB

Income
(represented by
housing price)

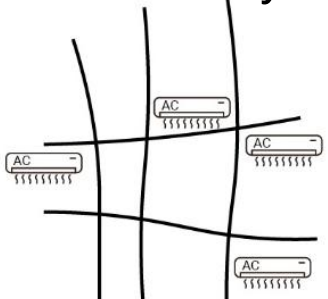
Building shade
coverage



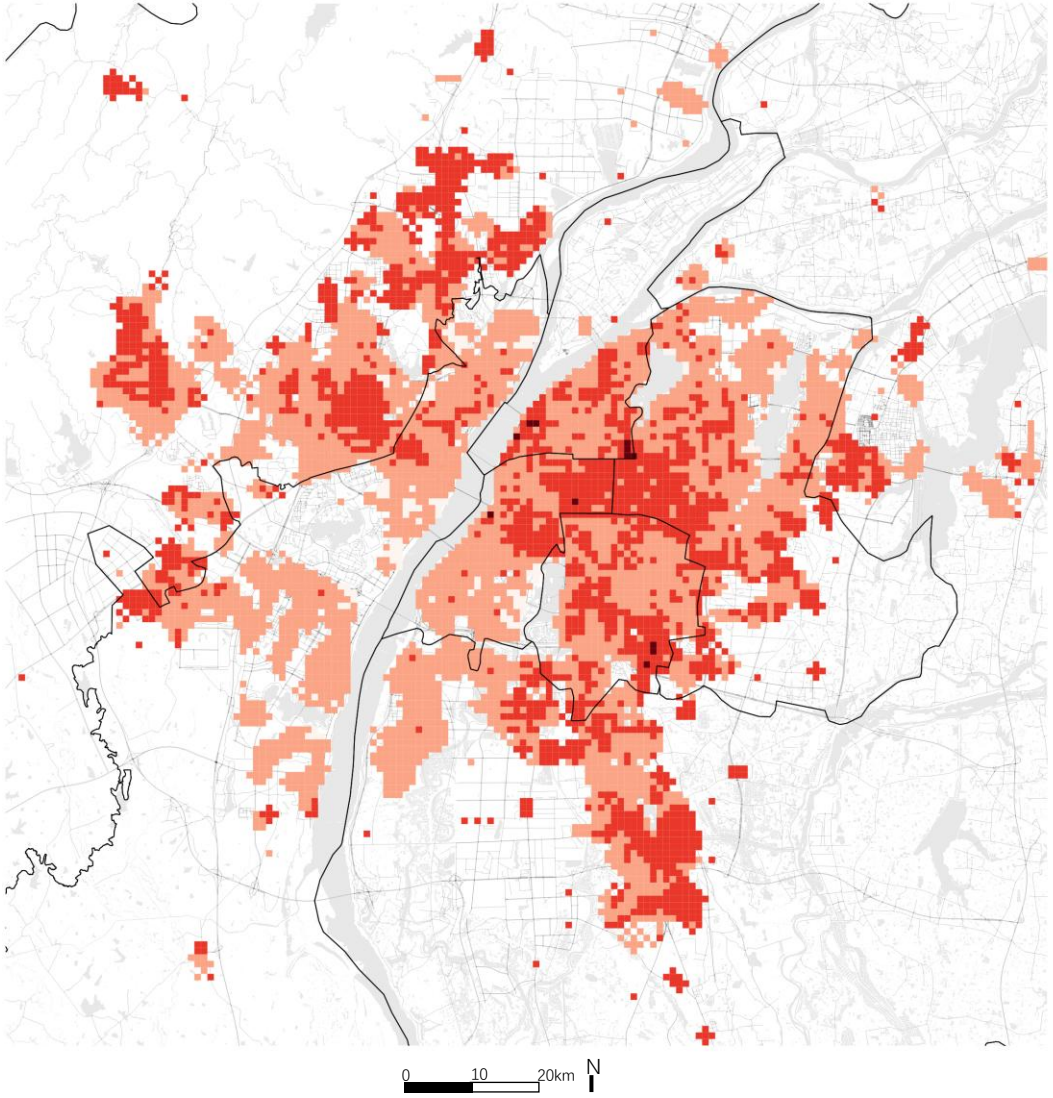
Health system
Accessibility



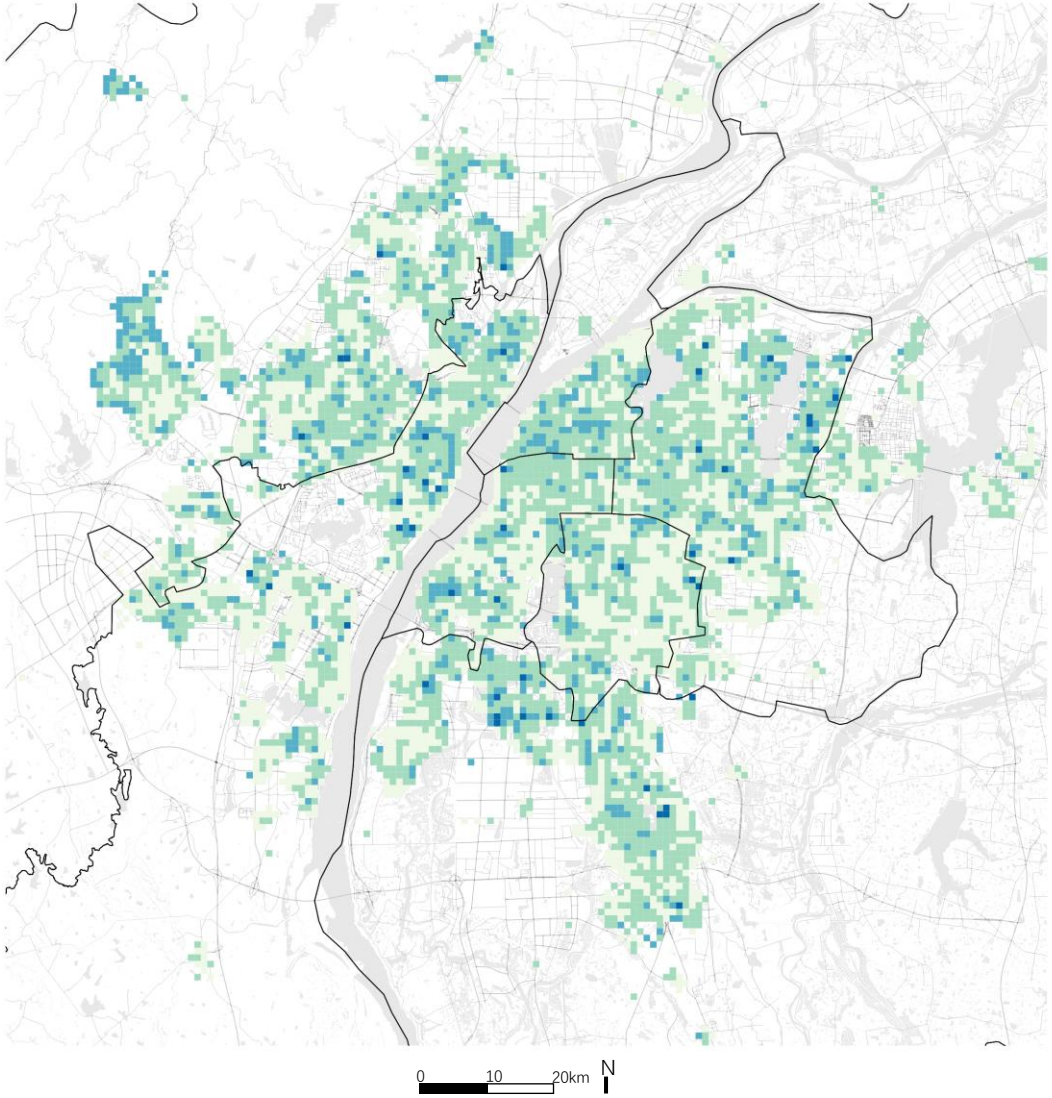
Tree Canopy
coverage



Heat Shelter
Accessibility

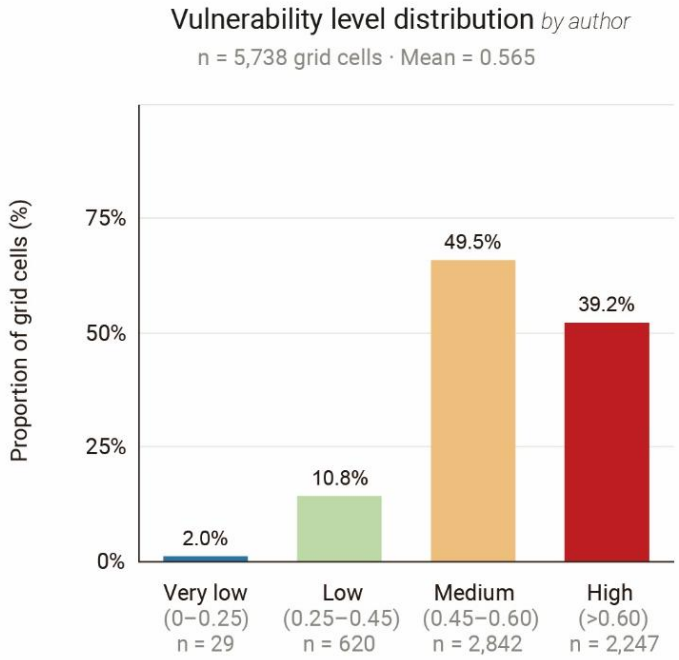


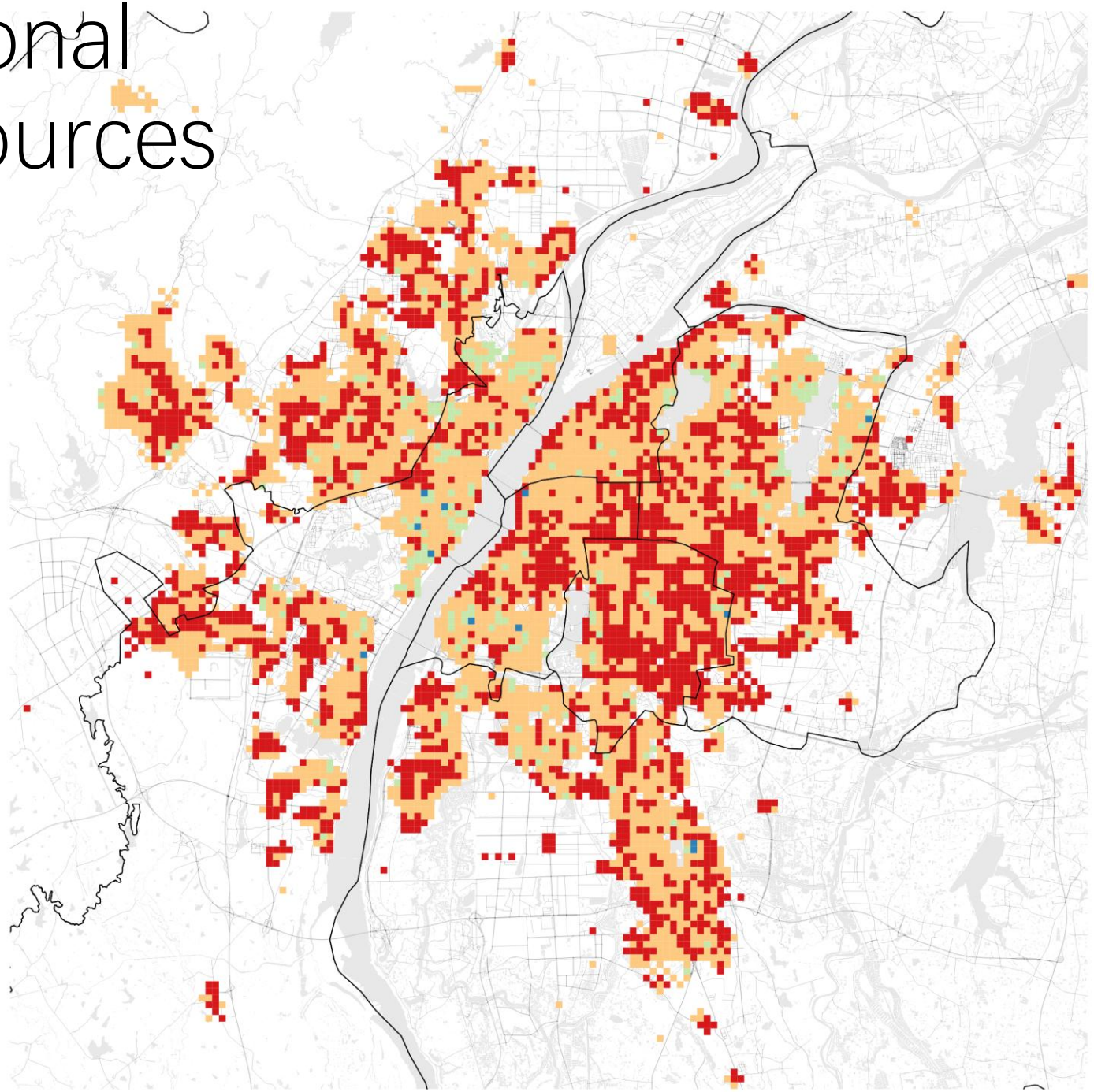
Sensitivity:
Where are the easily affected people?



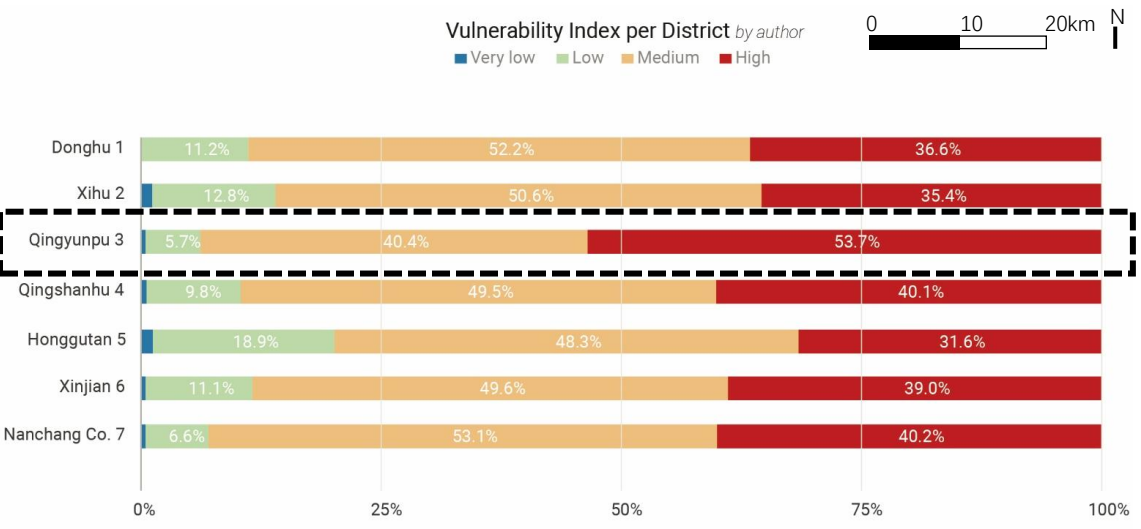
Adaptive Capacity:
Where are the cooling resources?

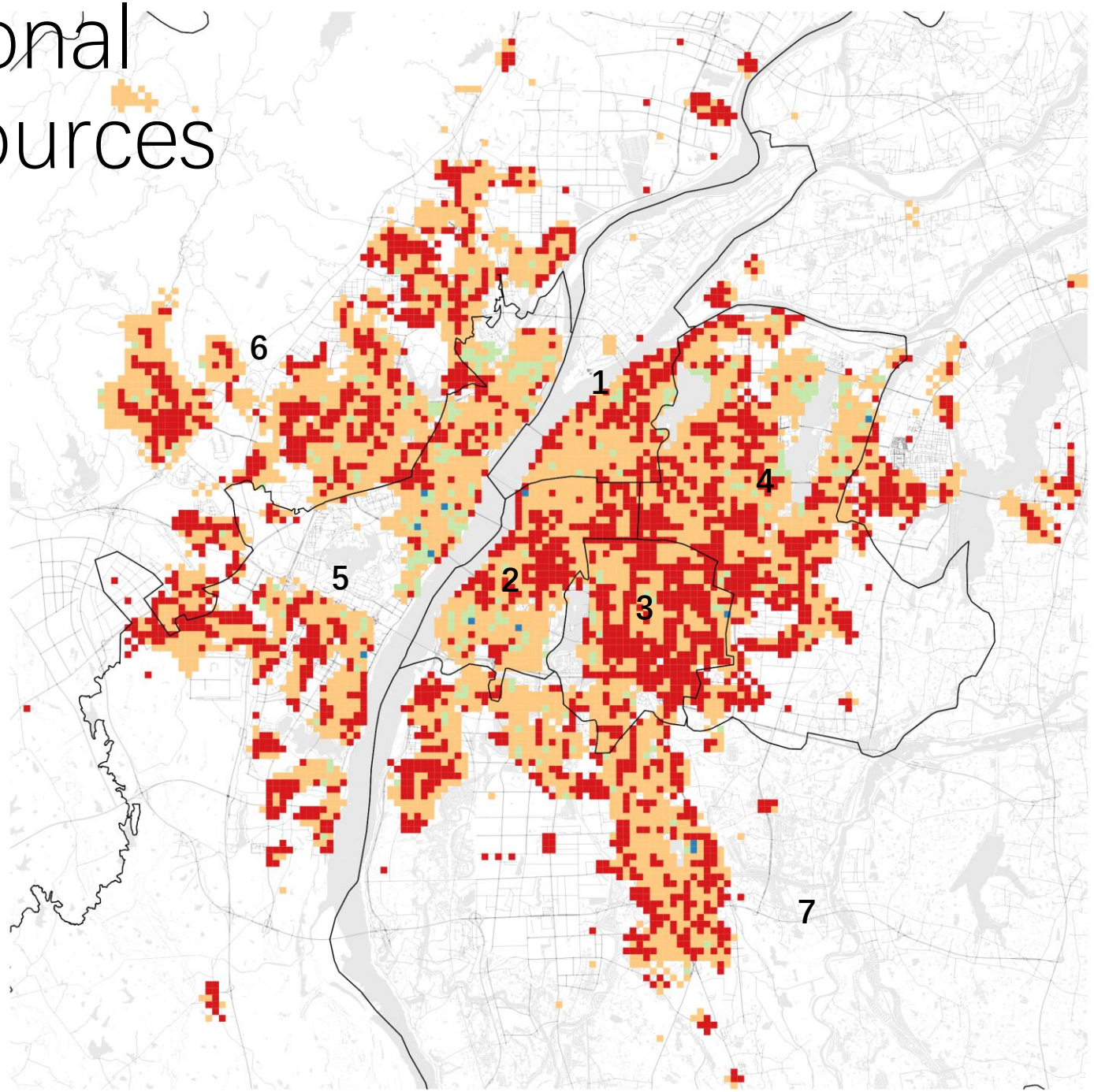
Vulnerability: Distributional inequity of cooling resources



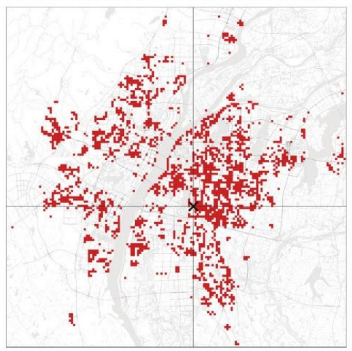


Vulnerability: Distributional inequity of cooling resources





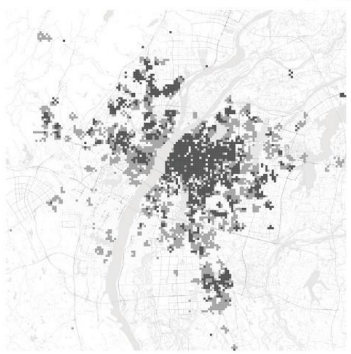
heat adaptive renovation guideline



selection based on vul-map

+

selection based on building age



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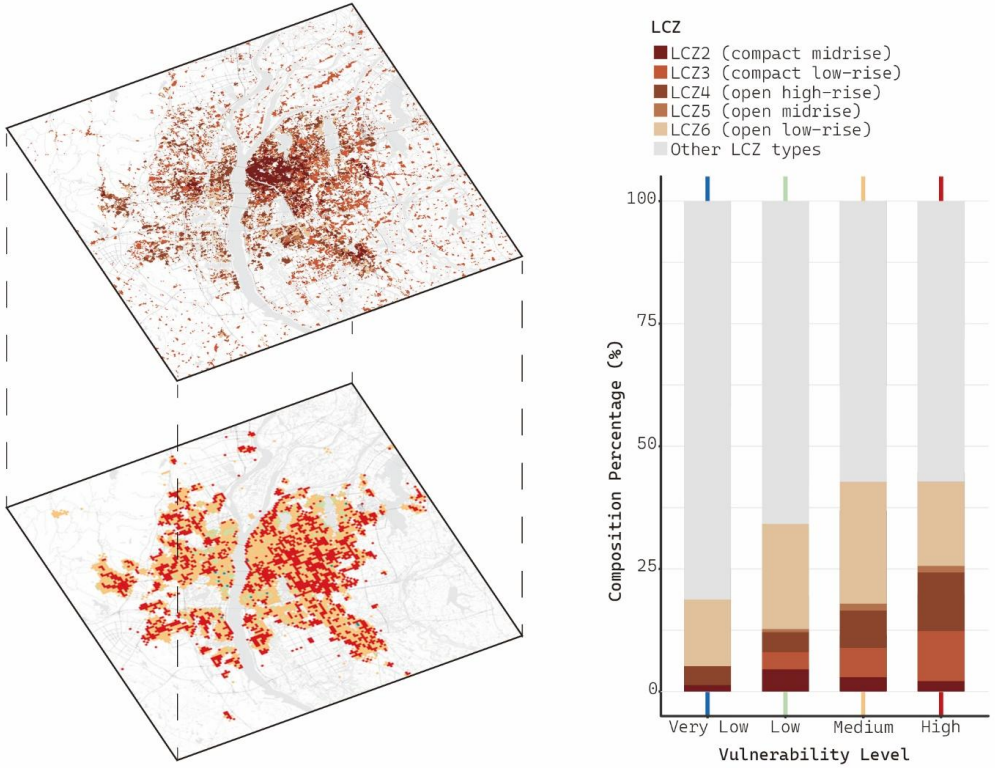
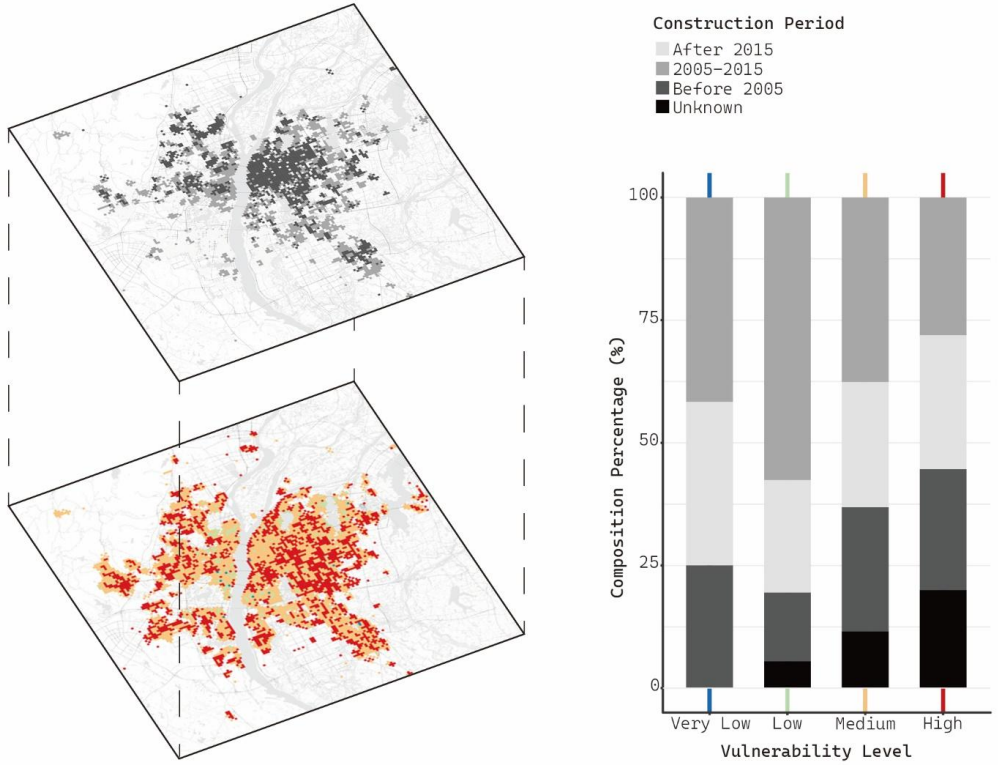
Vulnerability beyond Physical Form



Vulnerability + neighbourhood typology



Vulnerability + Construction period

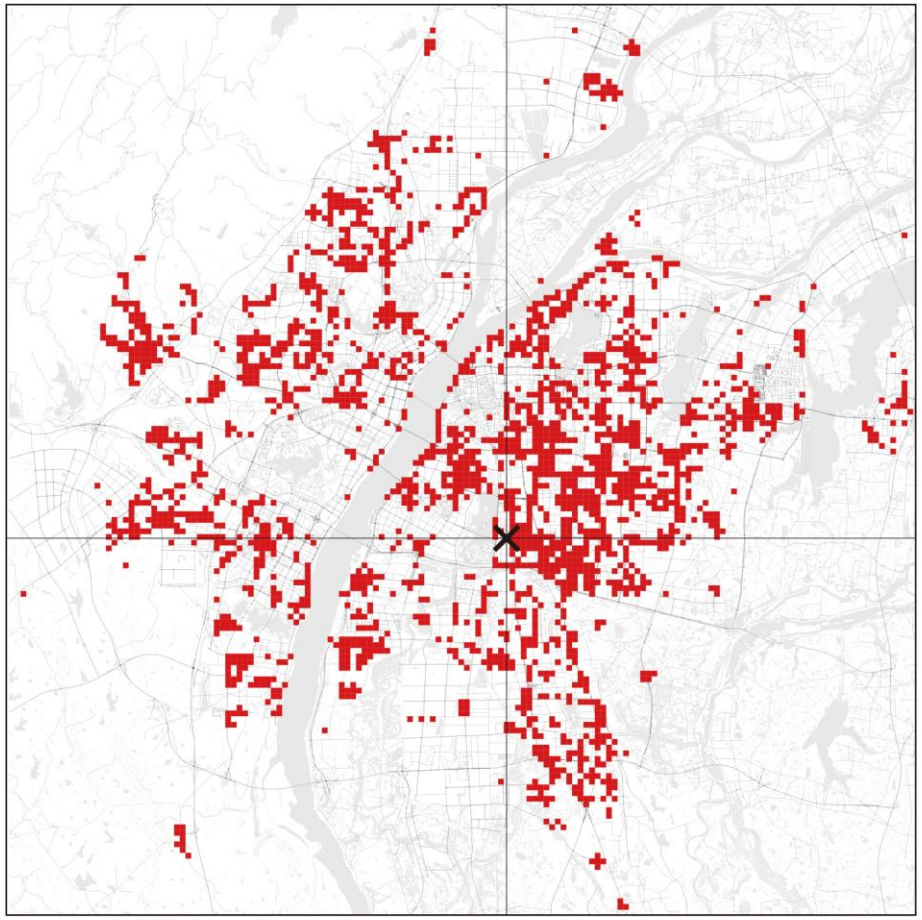
Vulnerability beyond Physical Form

No significant correspondence

There should be site-specific intervention for each type of neighbourhoods.

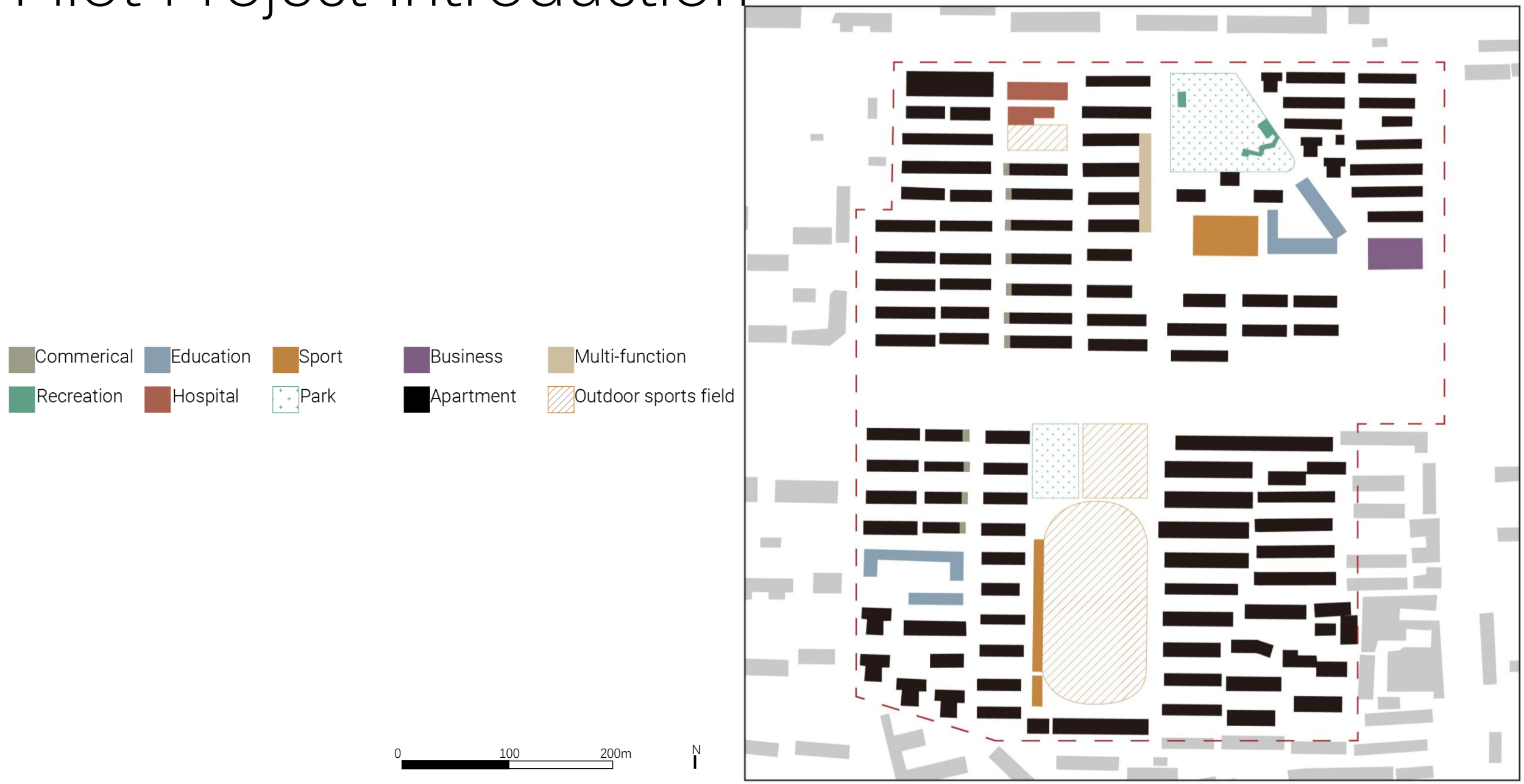
4. Strategy: Co-design

Pilot Project Selection



Site Selection within High Vulnerability area

Pilot Project Introduction



Pilot Project Introduction

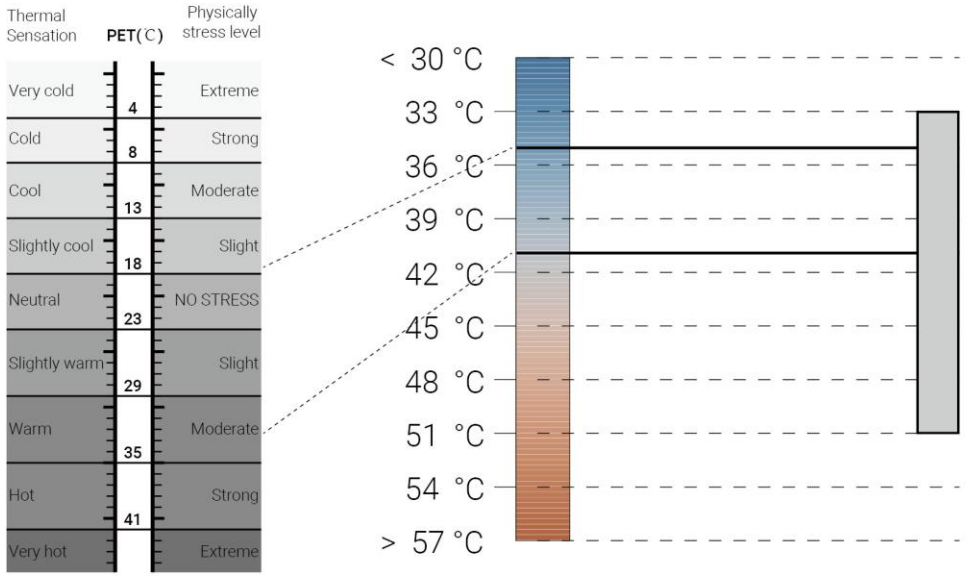
Before 2019

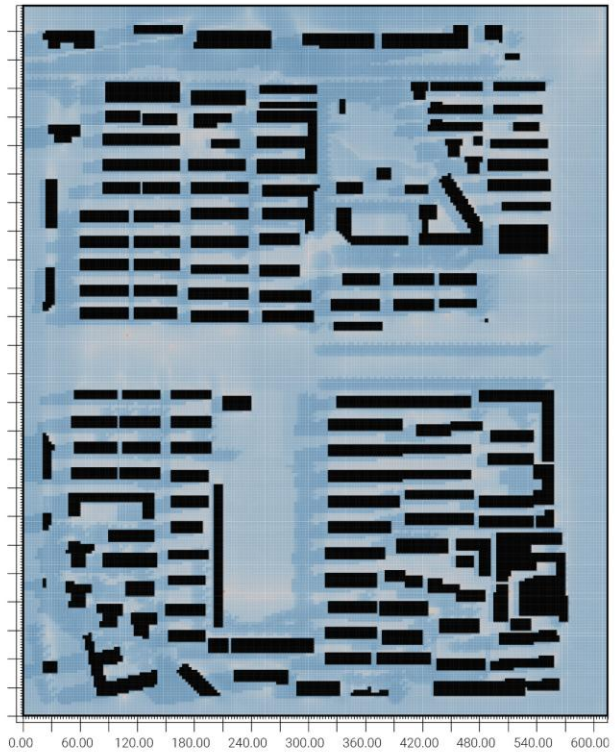
After 2021

Before 2019

After 2021

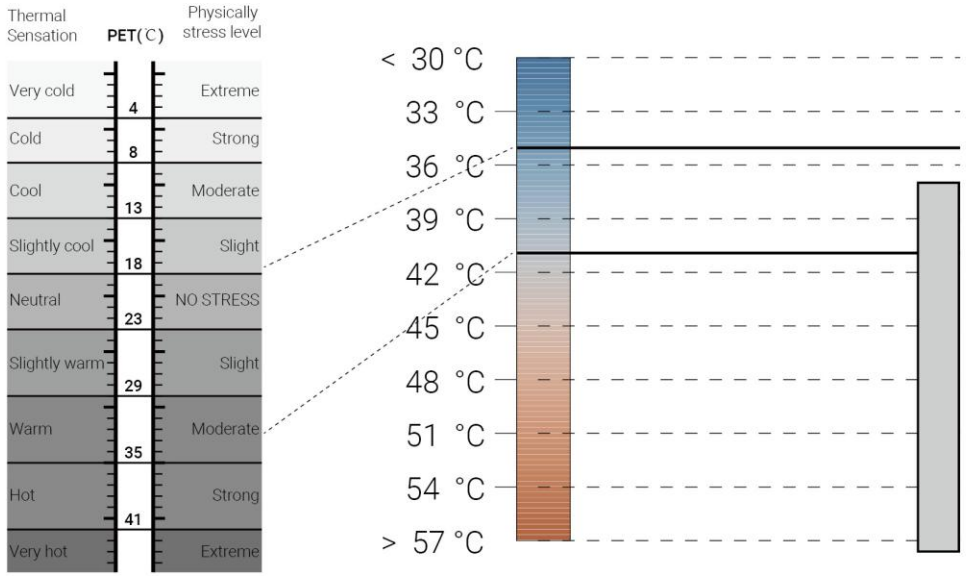
Current Thermal Environment





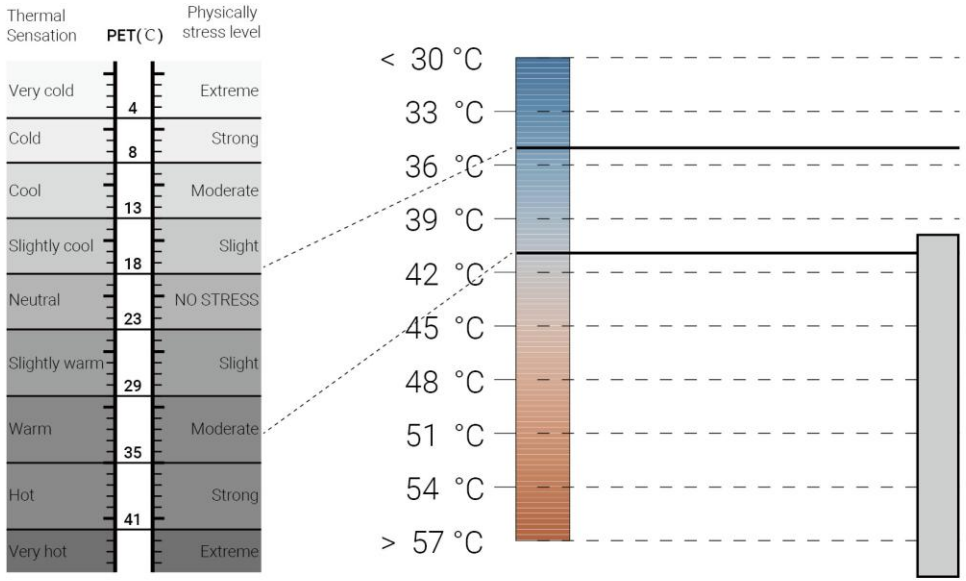
8:00

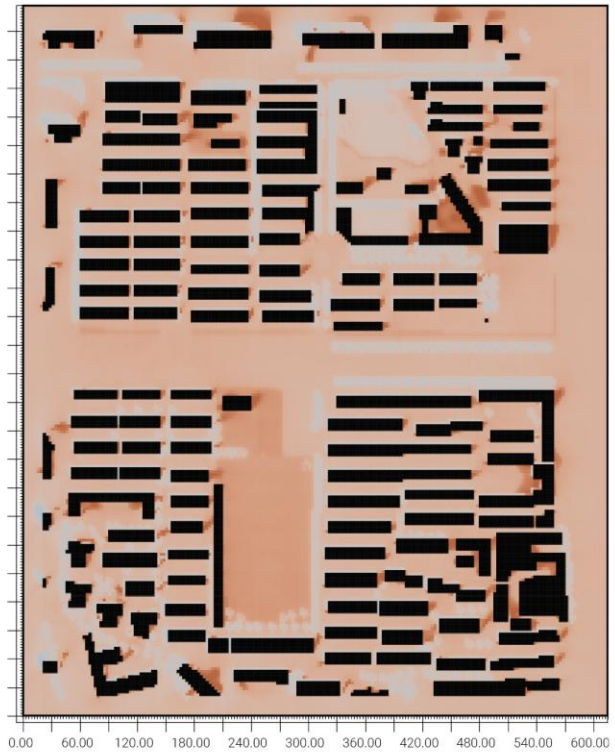
Current Thermal Environment



10:00

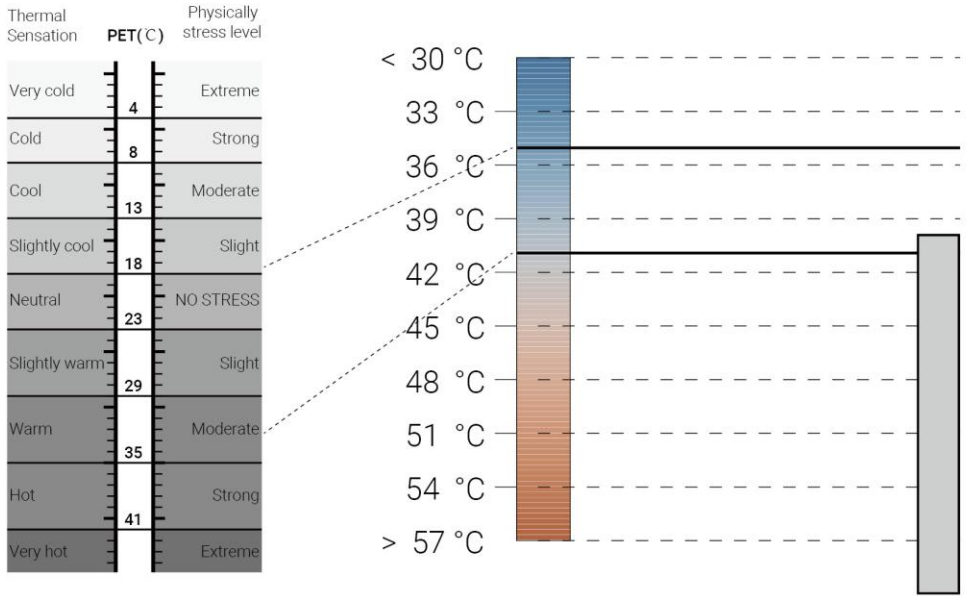
Current Thermal Environment

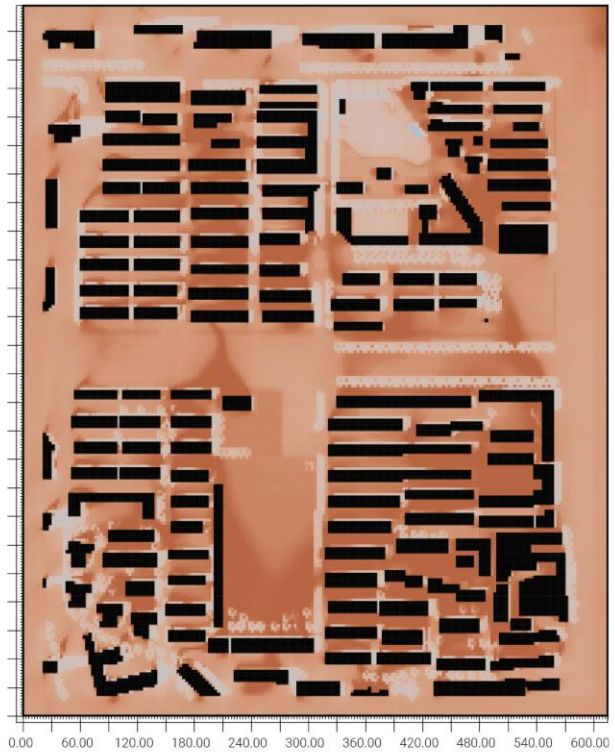




12:00

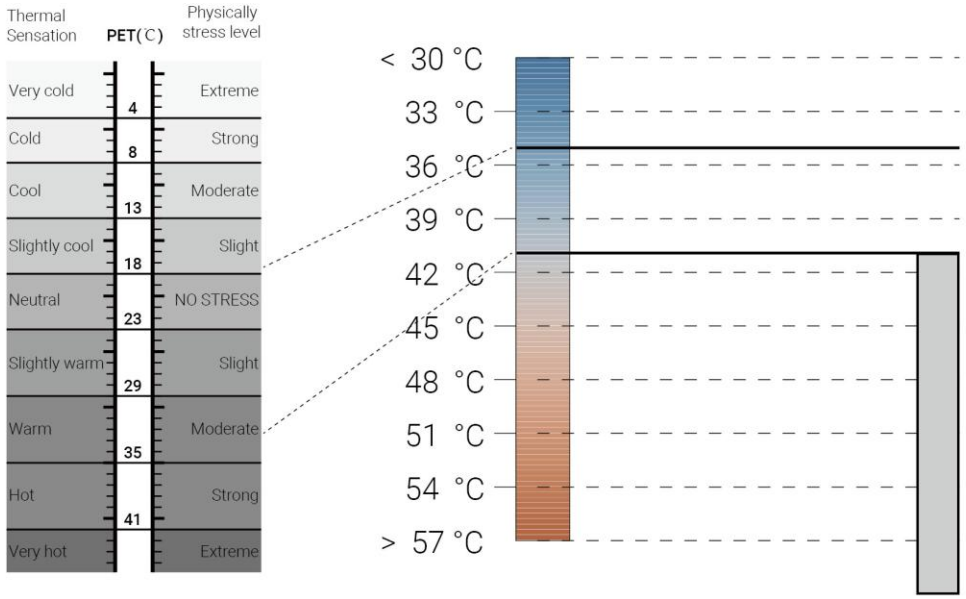
Current Thermal Environment

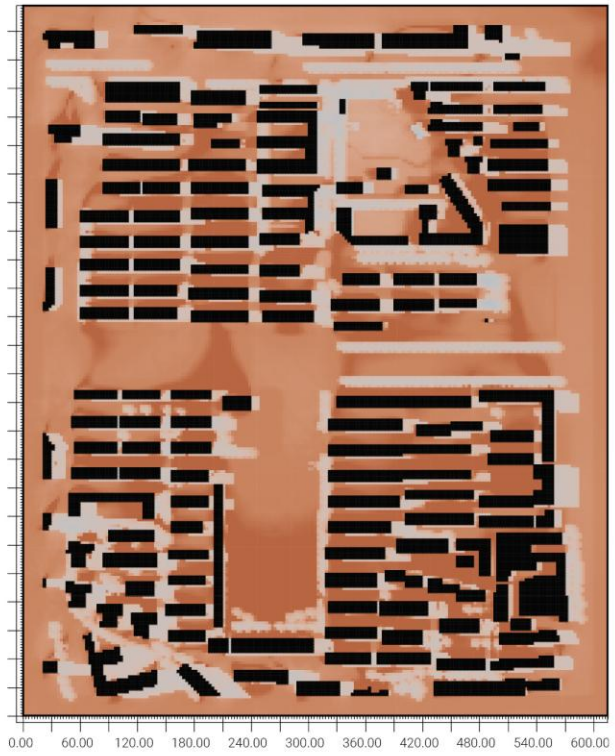




14:00

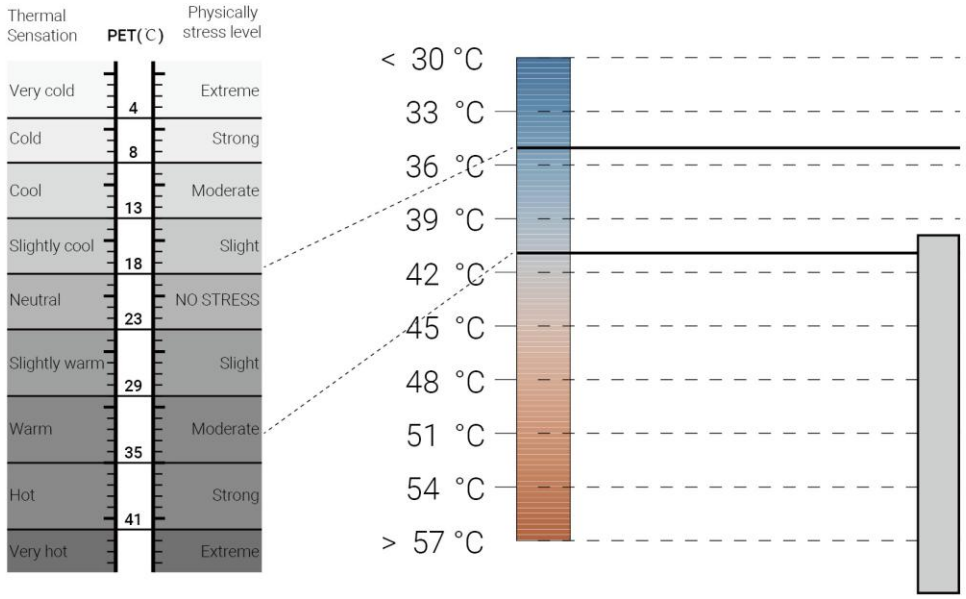
Current Thermal Environment

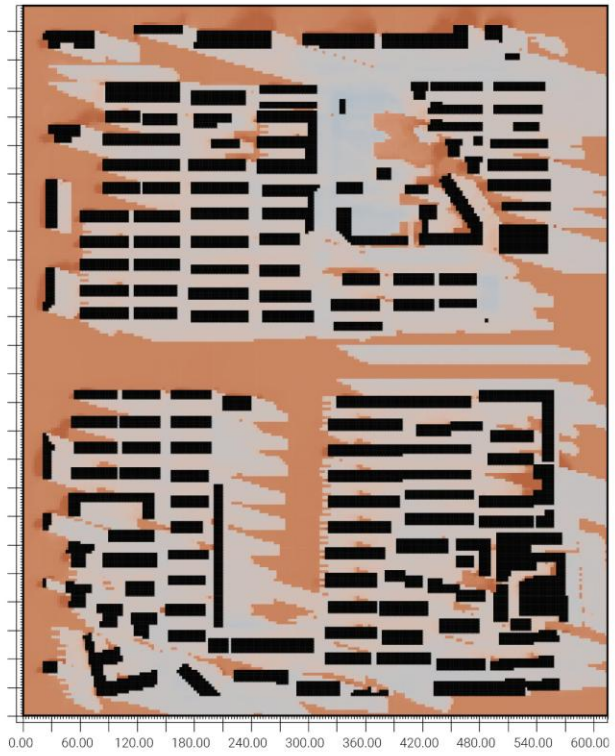




16:00

Current Thermal Environment





18:00

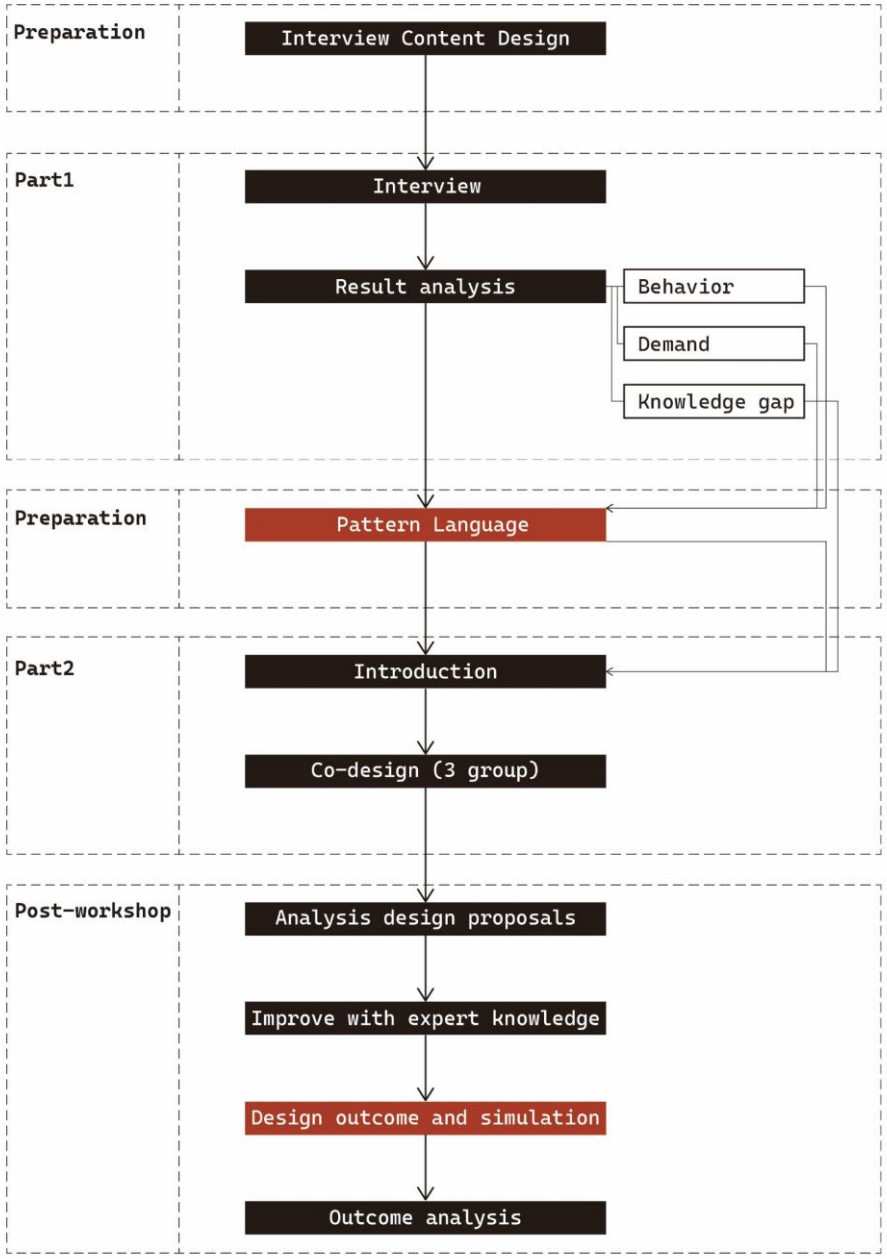
Co-design workshop

Interview: To learn the resident behavior pattern, demand and their knowledge base.

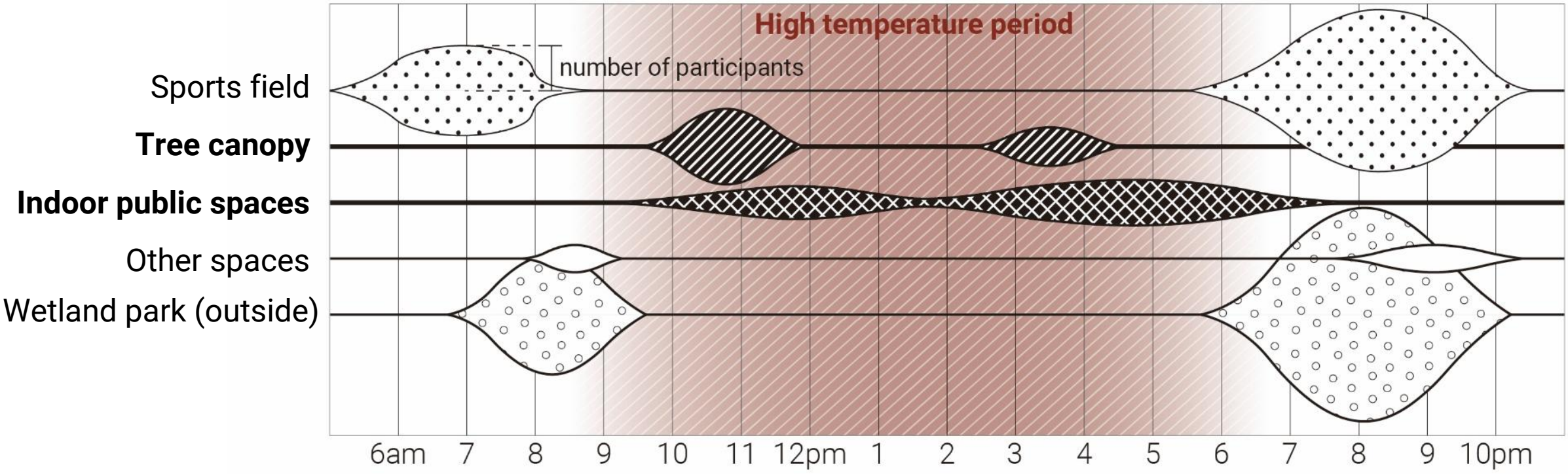
Participants:9 Average age: 42

Co-Design: Collect residents' proposal about heat adaptive renovation.

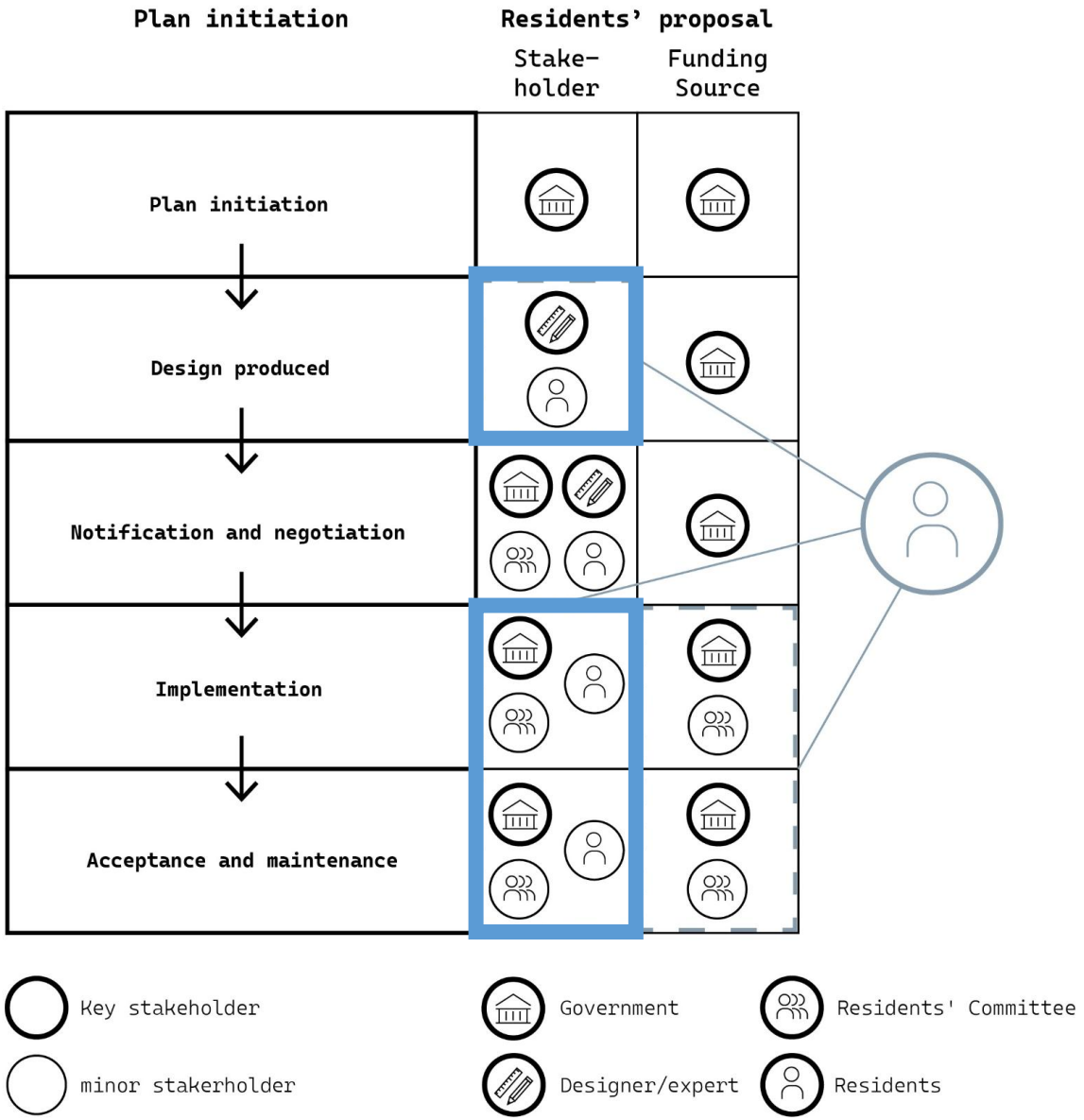
Participants:7 Average age: 45



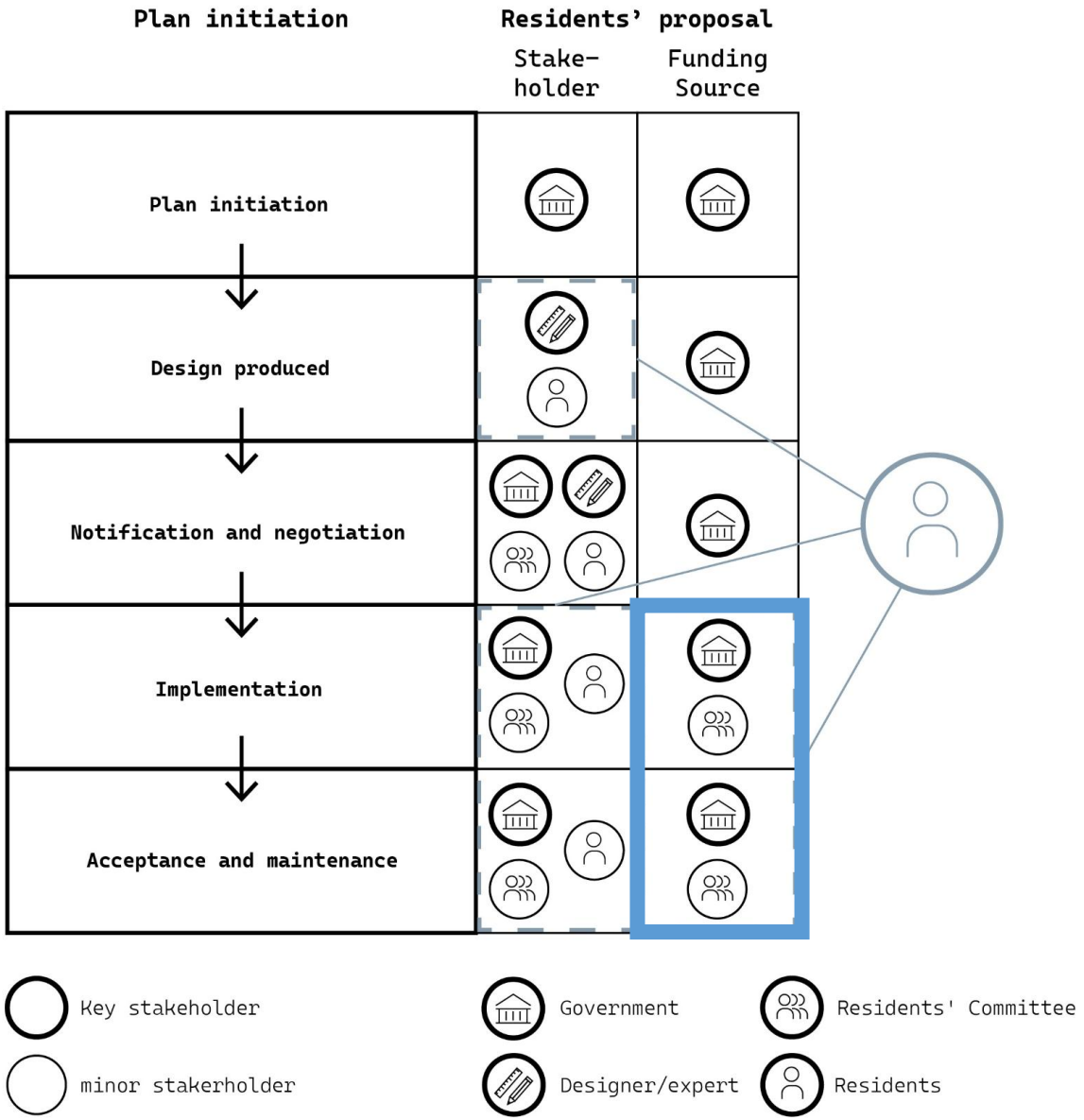
Interview: behavior patterns



Interview: Stakeholders in renovation



Interview: Stakeholders in renovation



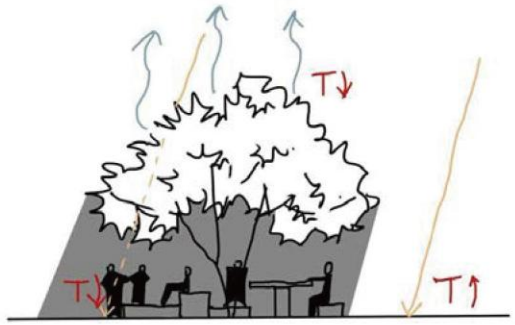
5. Strategy: Pattern Language

Pattern language design

- S1 More canopy between buildings
- S2 Combination of canopy with recreation
- S3 More structural shade between buildings
- S4 Combination of structural shade with recreation
- S5 Combination of building shade with recreation
- S6 More trees than shrubs
- S7 Parking lot and vegetation combination
- E1 Green facade
- E2 Green roof
- E3 Permeable pavement
- E4 Innovative permeable pavement
- E5 Vegetated balcony
- E6 Fountain in neighbourhood
- D1 Converting Ground-floor Function to Pilotis
- D2 Optimising Wind Corridors through addition
- D3 Large community garden
- D4 Add pocket park into community
- D5 Reflective surface
- D6 Underground parking lot
- D7 Parking garages
- A1 Air-Conditioned Community Cooling Space
- A2 More Medical Care Spot
- V1 Plant trees in downwind area

Pattern language design

S2 Combination of canopy with recreation



Limitation:

Spatial conflict:
Space beneath existing canopy may not be suitable for recreation implementation

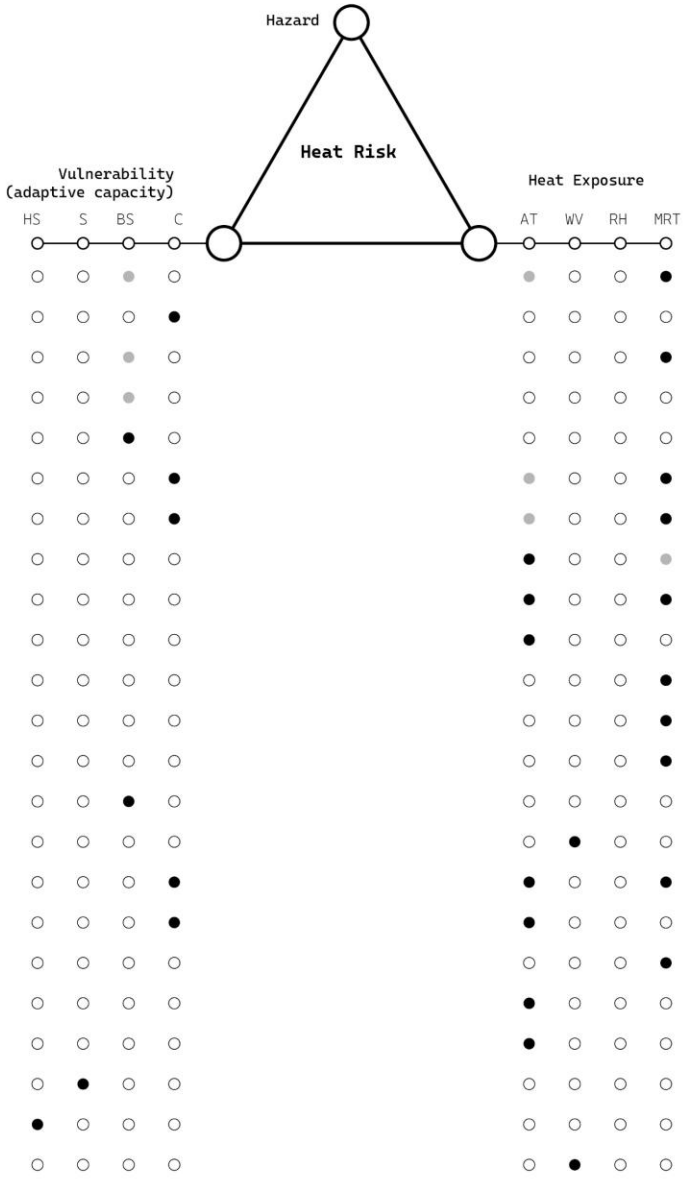
Explanation:
Trees significantly reduce surface temperature, air temperature and PET beneath their canopy. However, existing trees are often treated as purely aesthetic elements without associated seating or activity spaces. Combining rest areas and recreational facilities with existing tree canopy maximises the use of these natural cooling resources, providing accessible cool refuge for residents during hot summer periods.

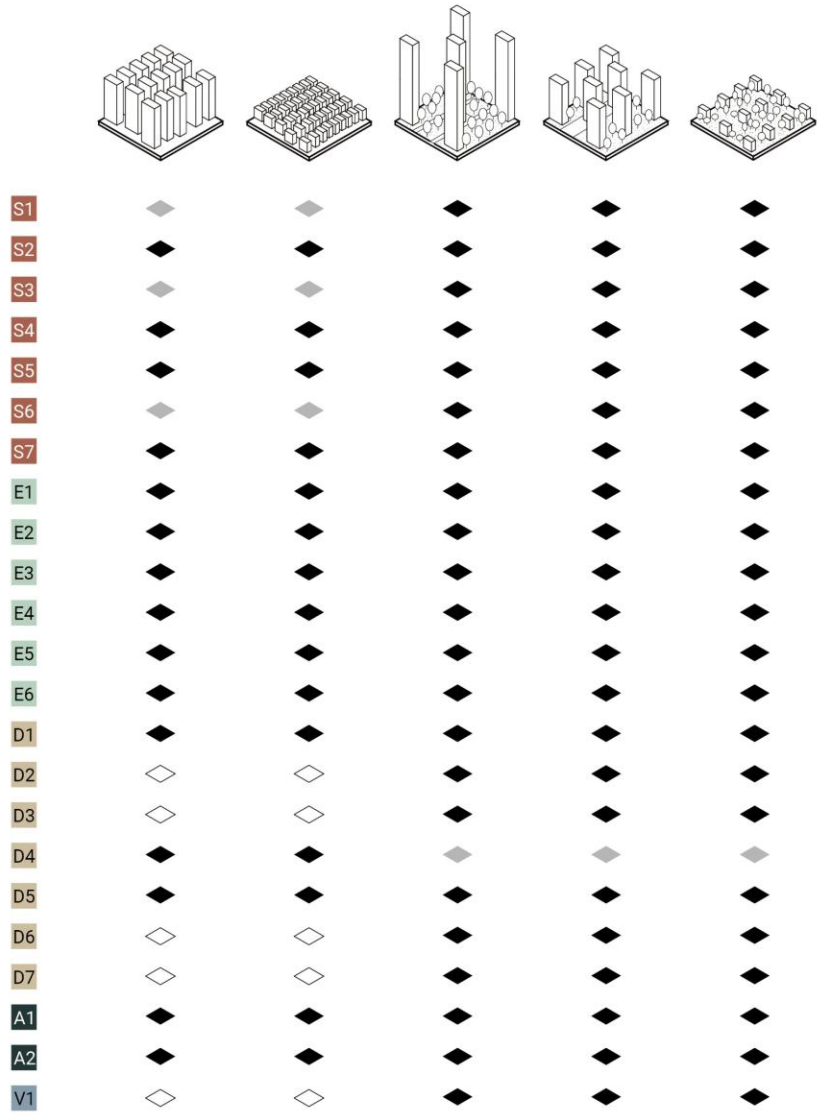
Source: (Probst et al., 2022), resident demand

Governance support:
Implementation party: government-led, community-led
Policy support: revise NODRP and UHAP
Funding: Government-funded, community-funded
Maintenance party: Government, community management

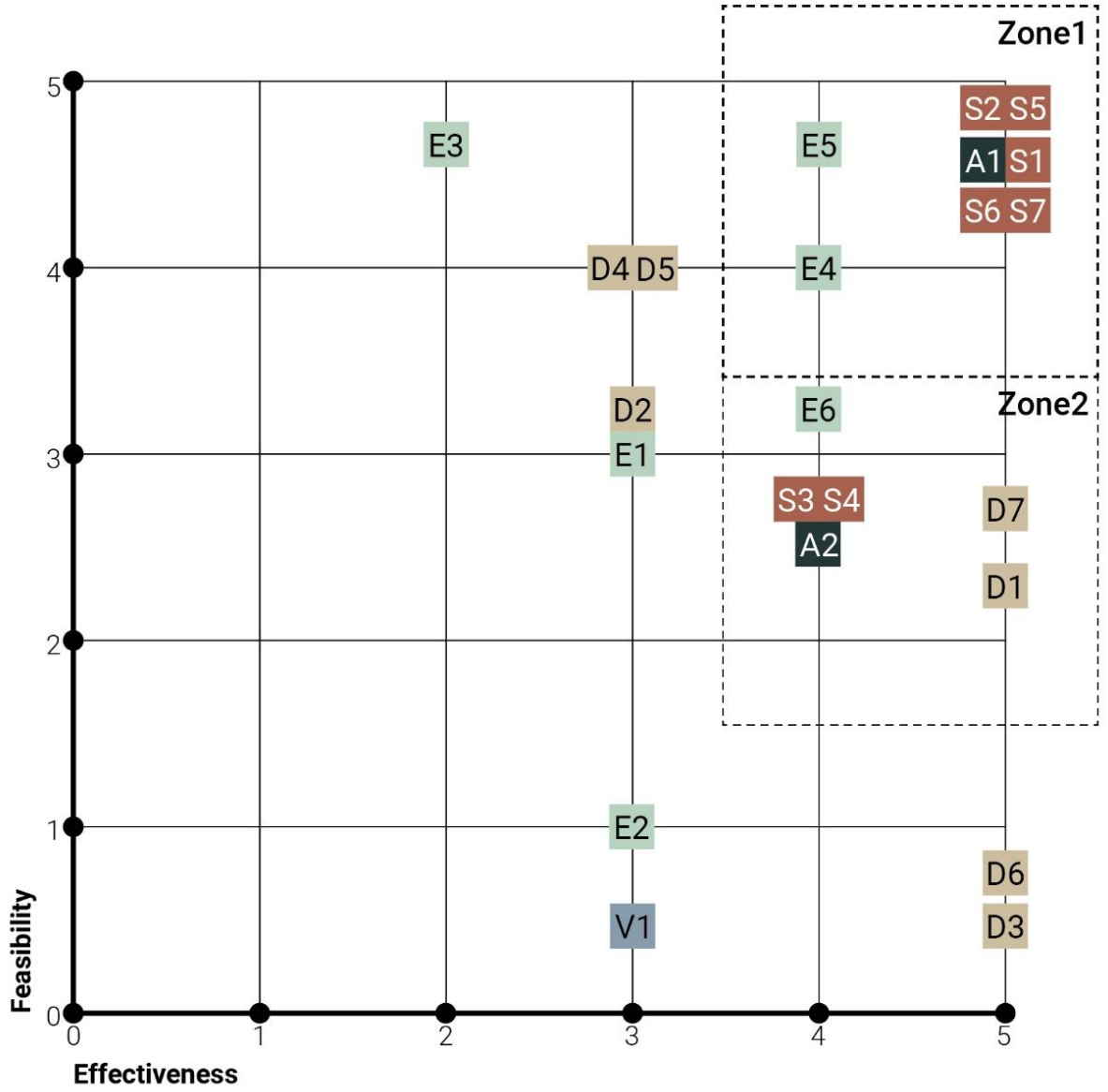
Effectiveness rating(by designer):
Feasibility rating(by resident):

Pattern language basis





Pattern language design

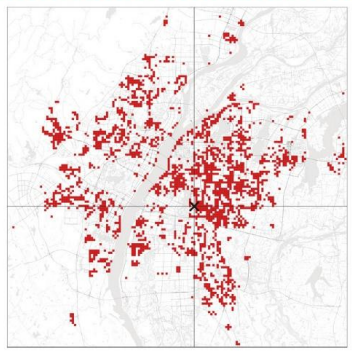


ZONE1:
prioritized actions

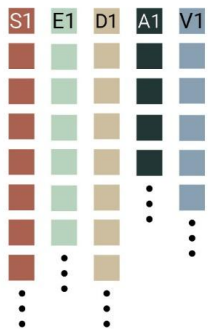
ZONE2:
secondary actions

OTHERS:
supplementary

heat adaptive renovation guideline

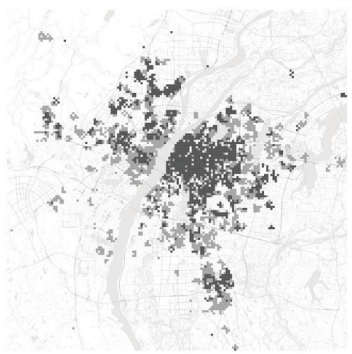


selection based on vul-map



heat adaptive pattern language

selection based on building age



strategy

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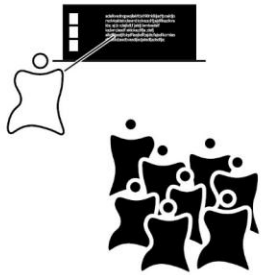
Evaluation Indicators for the Renovation of Old Residential Communities

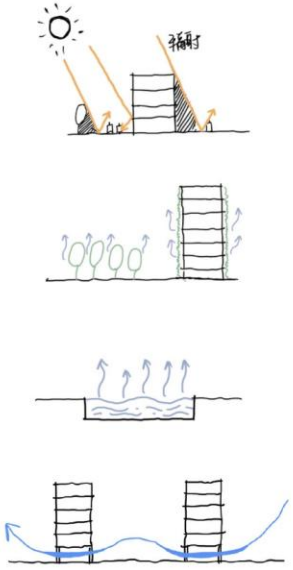
Green building codes

Old renovation process

Co-design process



STEP1: Concept definition
Using simple diagrams and accessible language, this step introduces the key mechanisms behind human thermal comfort, drawing on the recognition framework and findings from Part 1.



INTENTION
The intention is to close residents' knowledge gap on heat adaptation, reducing barriers to using the pattern language tool and engaging with heat-related issues more broadly.

STEP2: Pattern language introduction
Patterns are introduced by category according to their target spatial quality, and each category is explicitly linked to the thermal comfort mechanisms covered in Step 1.

S1 S2 S3 S4 S5 S6 S7
Shadow

E1 E2 E3 E4 E5 E6
Evapotransipitation

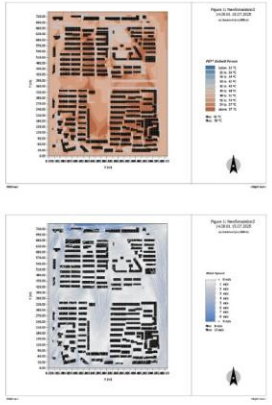
D1 D2 D3 D4 D5 D6 D7
Design

A1 A2
Active intervention

V1
Ventilation

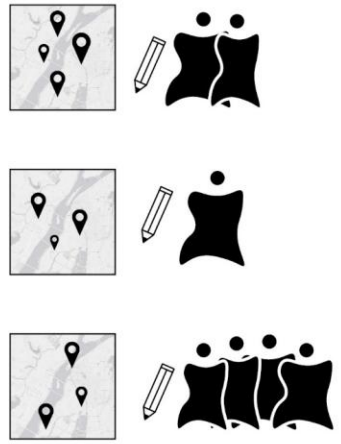
INTENTION
This structure allows residents without professional design knowledge to more readily understand and apply the patterns.

STEP3: Design guidance
Participants are provided with the hot and cool spot map from Part 1, the PET simulation map, and a wind direction map as spatial references.



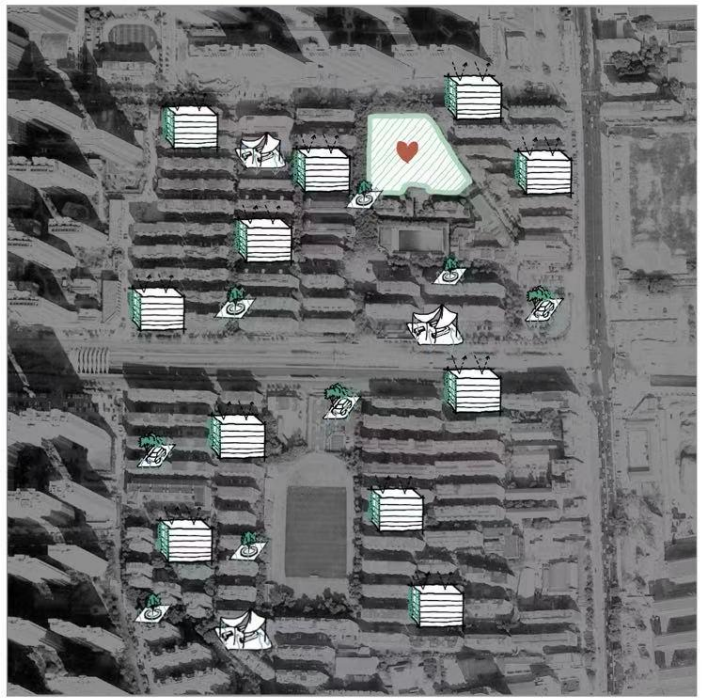
INTENTION
These materials offer concrete entry points for residents with no design experience, allowing them to begin by focusing on the areas most affected by heat.

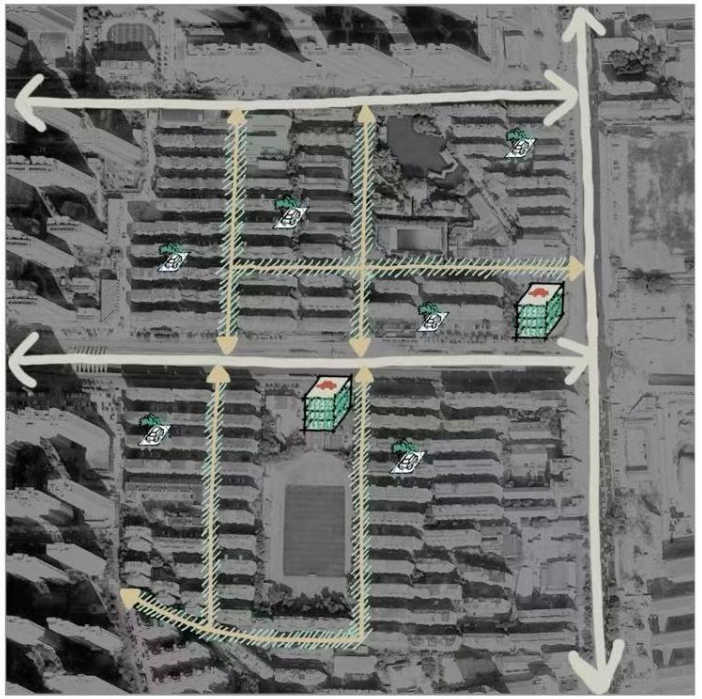
STEP4: Co-design
Participants are divided into three groups. Drawing on the background information from the previous steps and their own spatial preferences, each group applies patterns to a community map to produce a simple planning proposal, concluding with a short group presentation.



INTENTION
Dividing participants into groups encourages discussion and exchange of ideas while generating a range of diverse proposals for analysis.

Resident Proposals





Resident Proposals

2 More medical care spot

5 Vegetated balcony

6 Fountain in neighbourhood

4 1 Add pocket park into community
+Air-conditioned community cooling space

2 4 Combination of canopy with recreation
+innovative permeable pavement

4 4 Combination of structure shade with recreation
+innovative permeable pavement

5 4 Combination of building shade with recreation
+innovative permeable pavement

7 3 4 Parking lot and vegetation combination
+permeable pavement/innovative permeable pavement

Resident Proposals

1 More canopy between buildings

3 Permeable pavement

4 Add pocket park into community

7 Parking garages

Resident Proposals

1 More canopy between buildings

3 More structure shade between buildings

5 Vegetated balcony

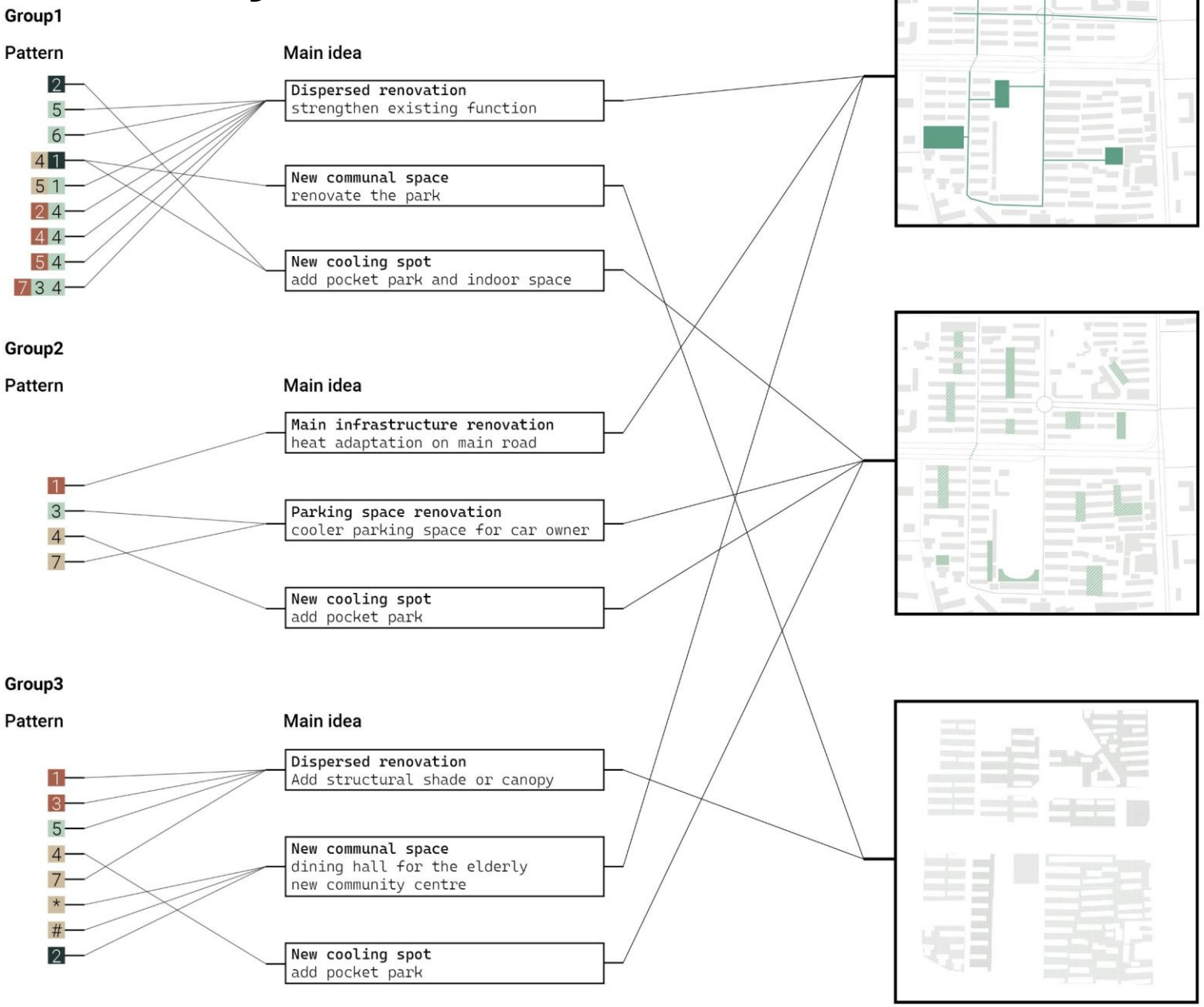
4 Add pocket park into community

7 Parking garages

* Add a community dining hall

Change abandoned building into community center

Proposal Synthesis



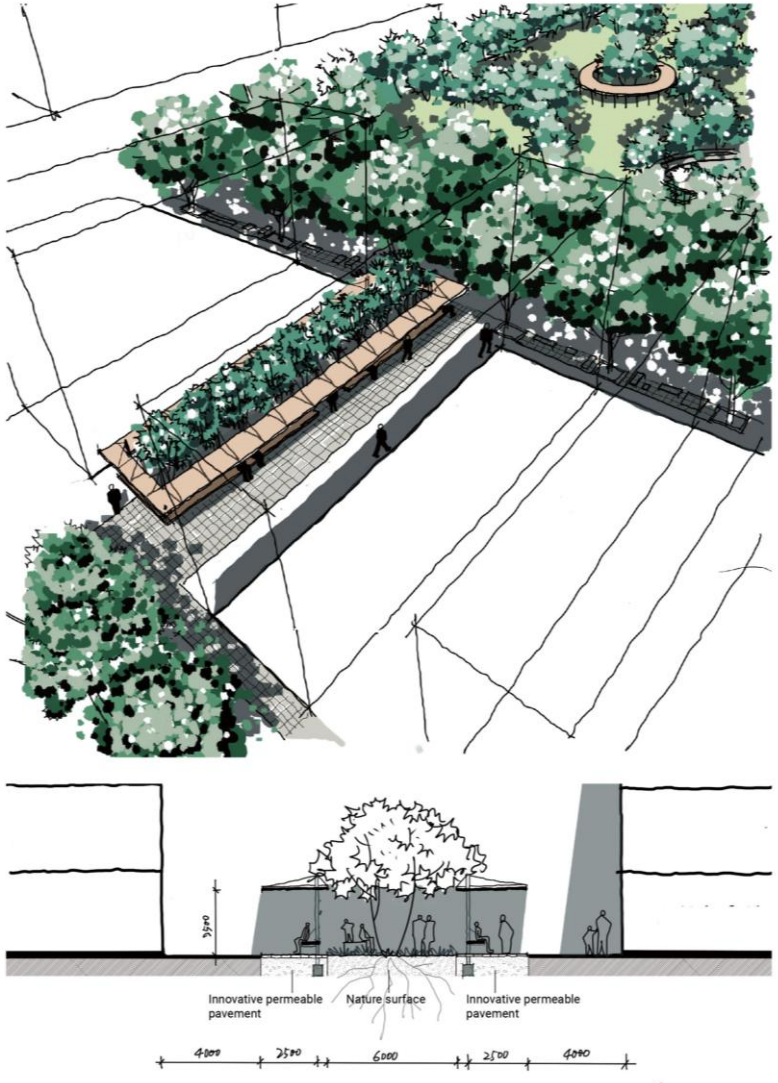
Level1 Main Cooling Infrastructure
Key communal spaces proposed by residents, together with existing cooling spots, are connected by shaded pathways along the main roads within the community. The primary purpose of these pathways is to minimise heat exposure when residents travel between destinations. Beyond circulation, the pathways can also serve as informal rest areas, combining shade with opportunities for recreation.

Level2 Pocket Park
Since residents tend to seek the nearest available cooling spot rather than travelling far, pocket parks are introduced as localised cooling spaces distributed across the neighbourhood. Sites are selected in two ways: first, locations with existing good canopy cover are prioritised; second, additional sites are identified to fill gaps in coverage not reached by existing pocket parks or Level 1 cooling infrastructure.

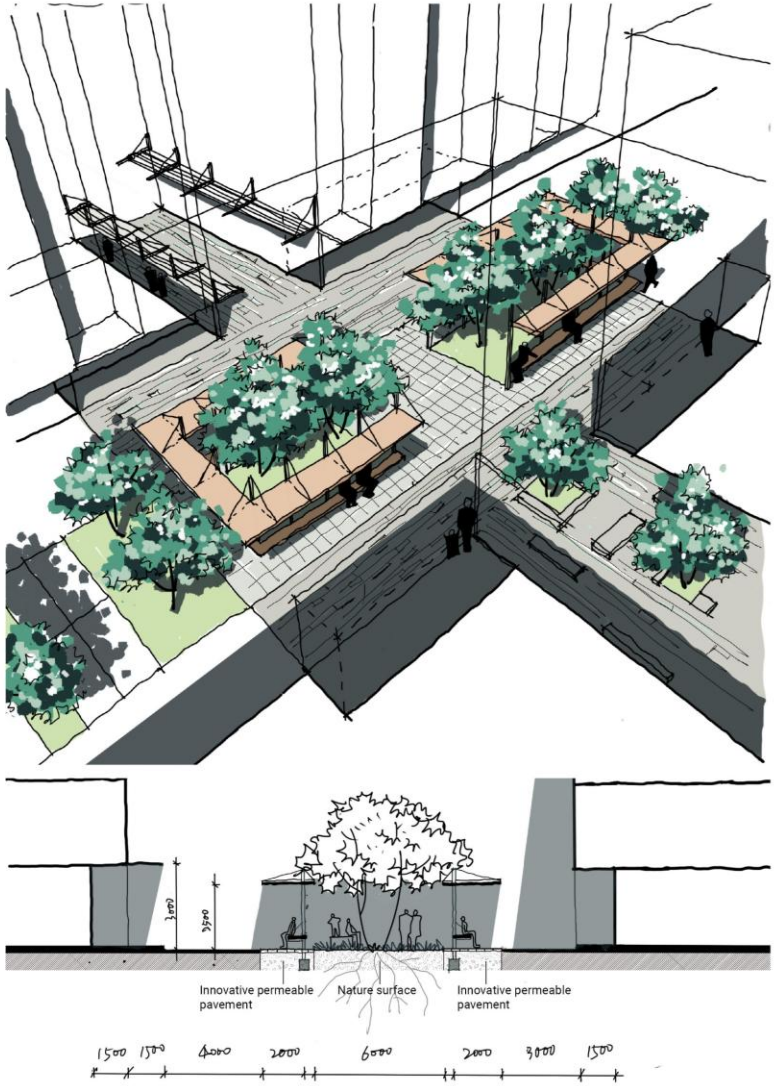
Level3 General renovation
The remaining spaces — including outdoor parking lots and open areas between buildings — are addressed in this final phase. As these spaces do not require changes to their functional layout, renovation focuses on adding canopy cover and replacing hard surfaces with heat-mitigating materials across the wider neighbourhood.

Final Proposal

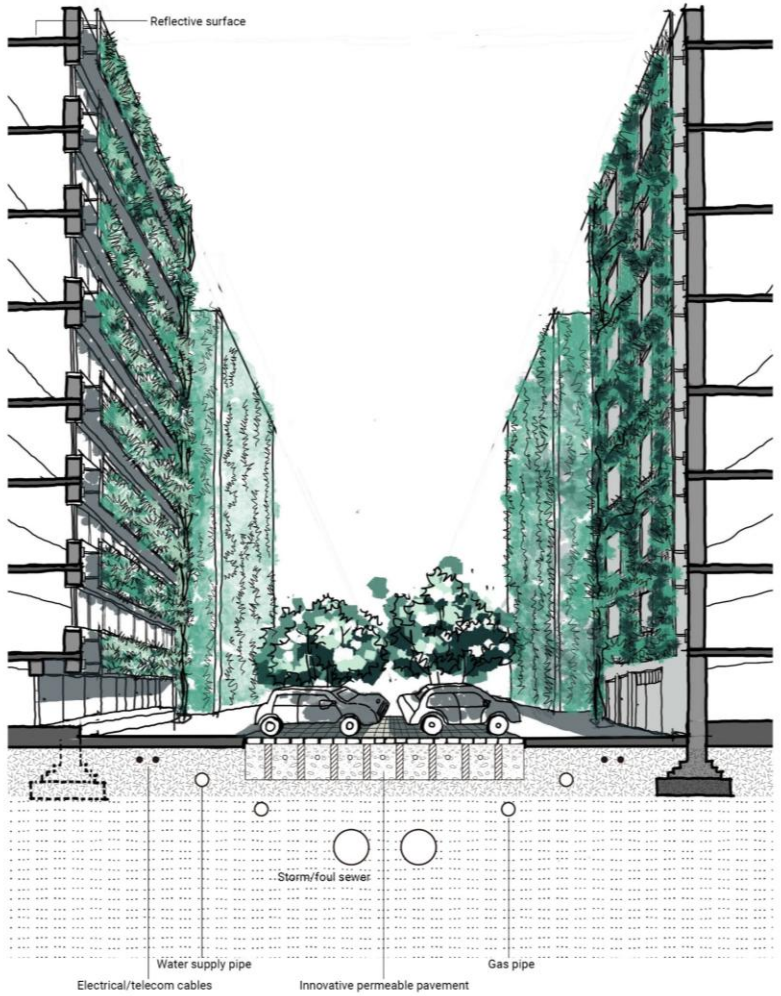
Layer 1



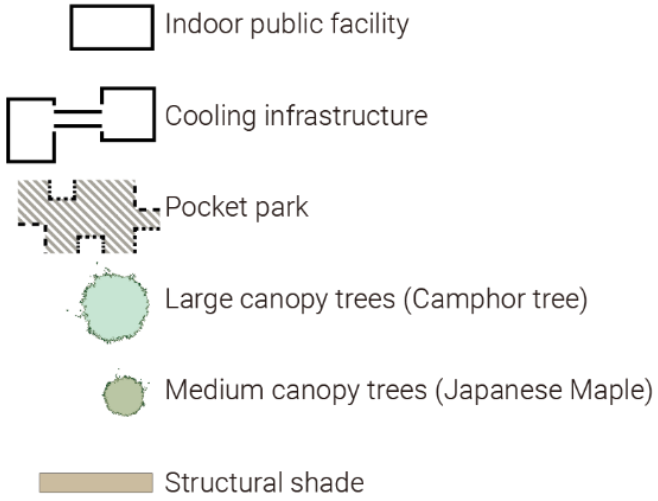
Layer 2



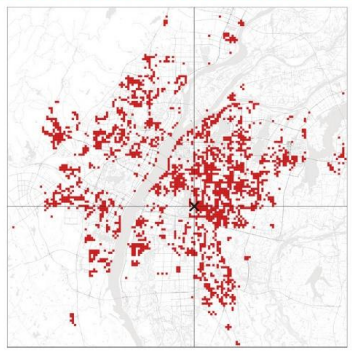
Layer 3



Final Proposal

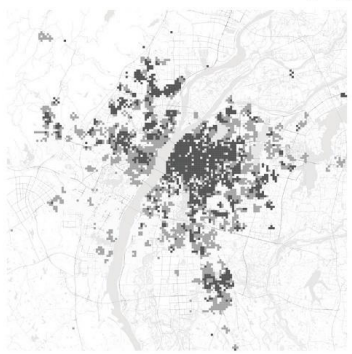


heat adaptive renovation guideline

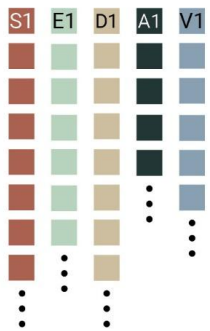


selection based on vul-map

selection based on building age



Old renovation process



heat adaptive pattern language

strategy

Implementation plan
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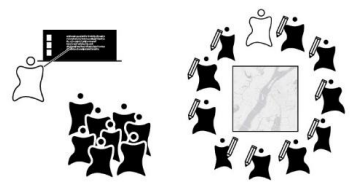


Participatory design

Design by expert

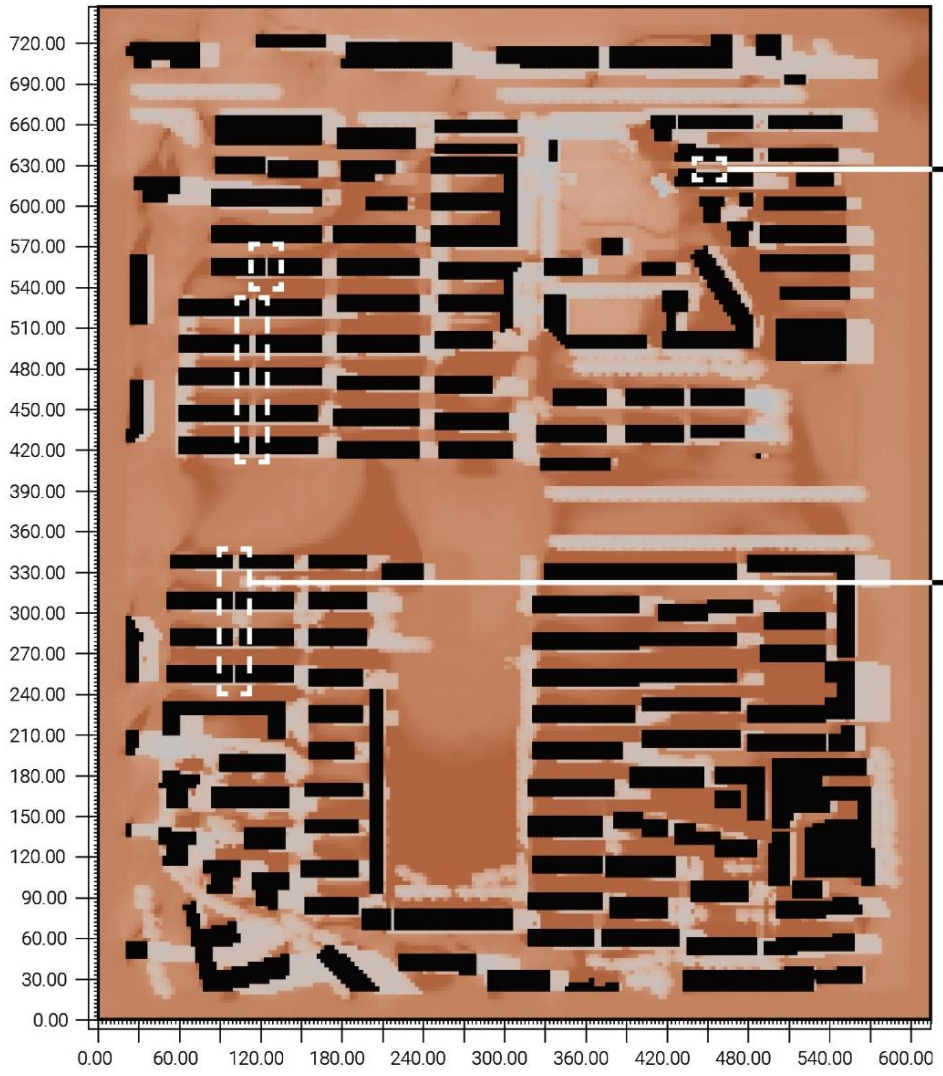
Technical guidance
Technical Guidelines for the Renovation of Older Residential Communities in Jiangxi Province

Acceptance and evaluation

Evaluation Indicators for the Renovation of Old Residential Communities

Green building codes

Simulation of Intervention



Coolest spot after intervention

Temperature drop
From 54 to 39 °C

Pattern applied:

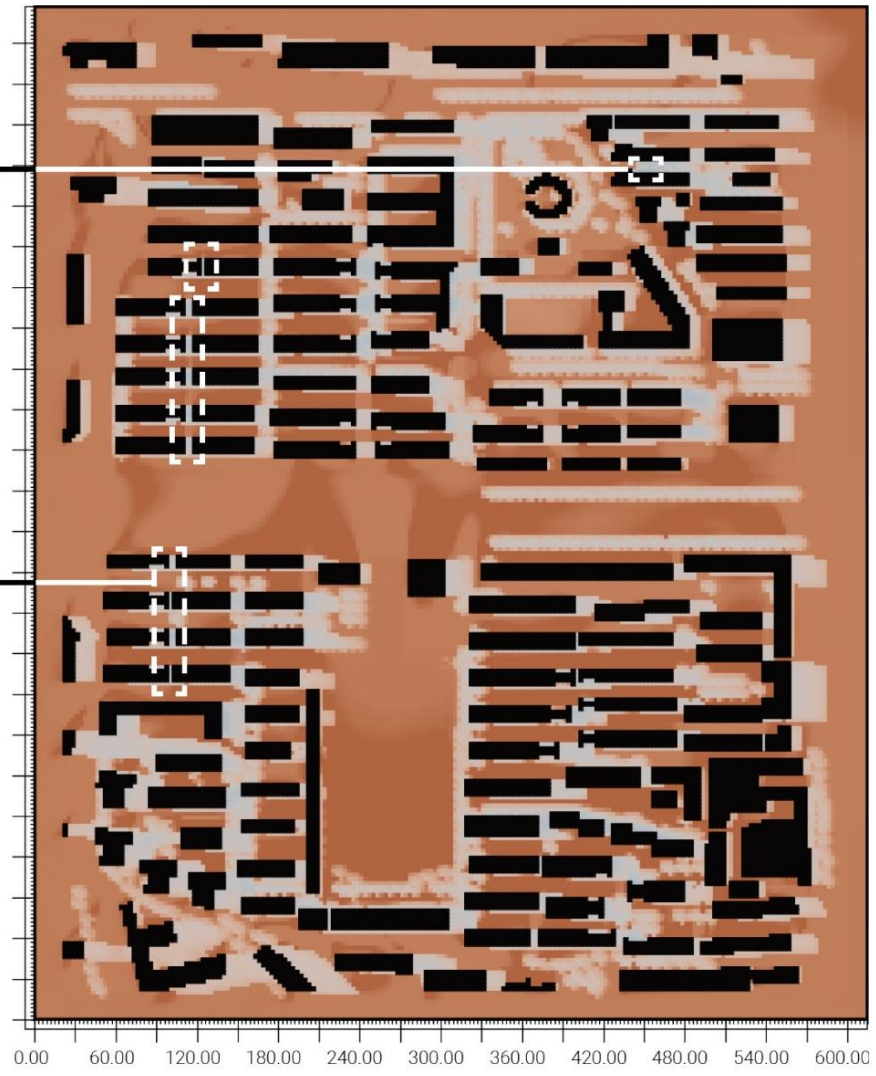
S5 E1 E4 D4

Coolest spot after intervention

Temperature drop
From 42.5 to 39.5 °C

Pattern applied:

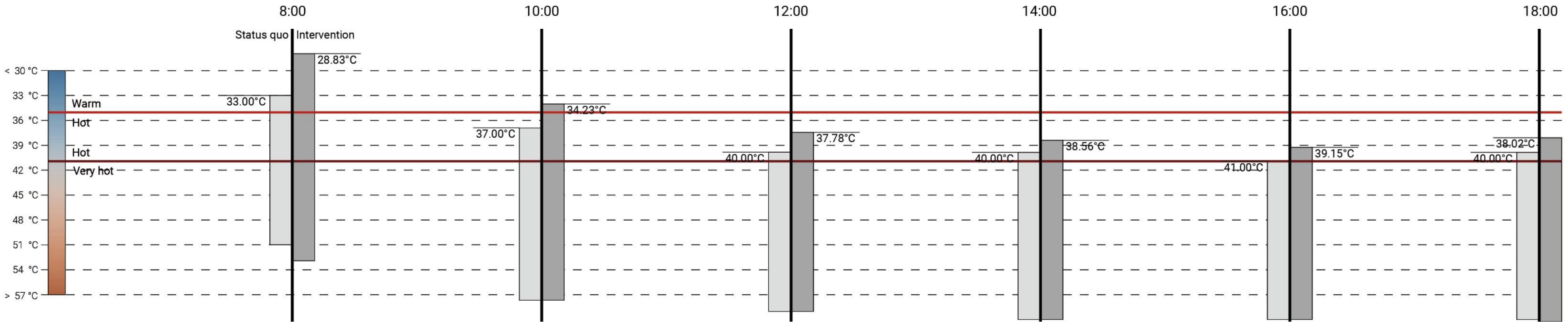
S1 S2 S6 E1 E4



16:00 Before

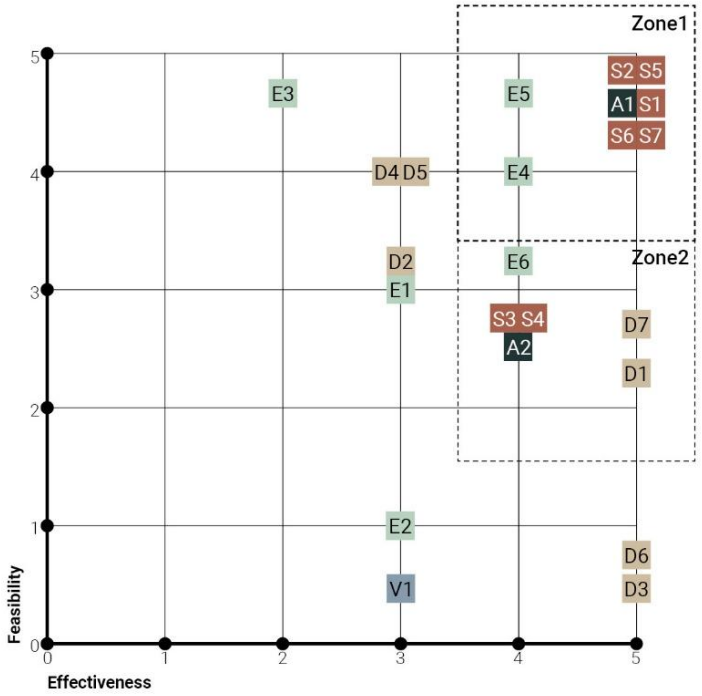
16:00 After

Simulation of Intervention

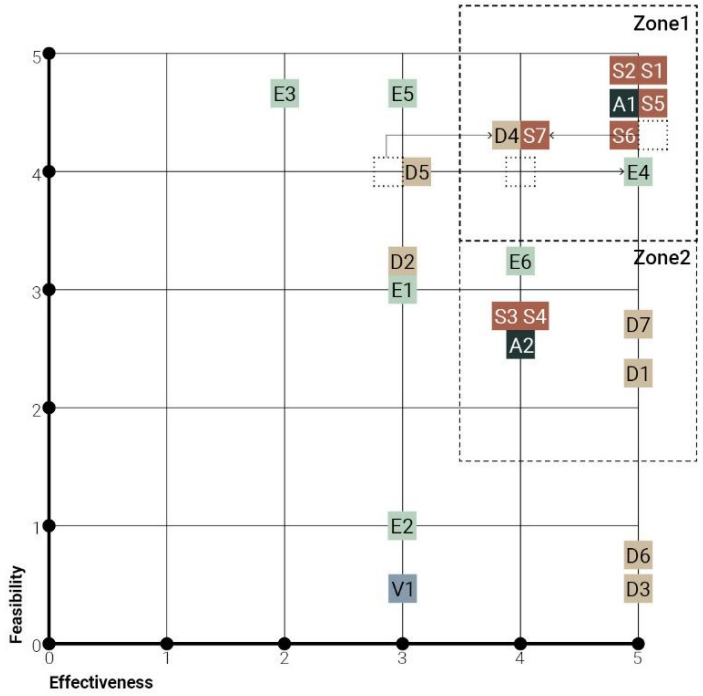


Recommendation Matrix Iteration

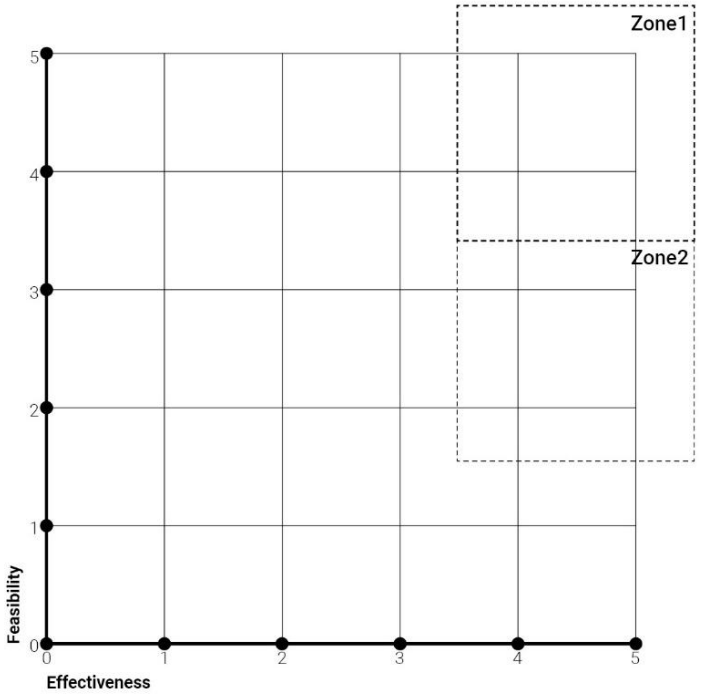
Matrix before intervention



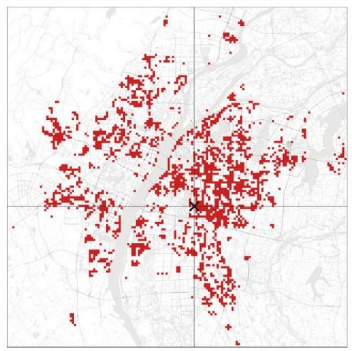
Matrix after 1st intervention



Matrix after 2nd intervention/
intervention in other neighbourhoods...



heat adaptive renovation guideline



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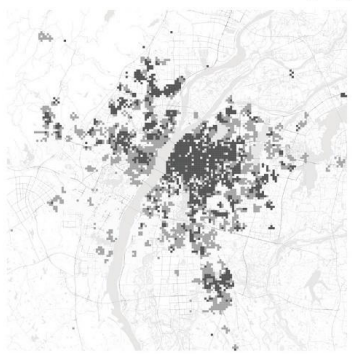
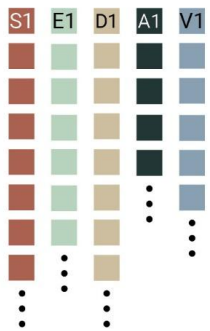


selection based on building age

Old renovation process



heat adaptive pattern language

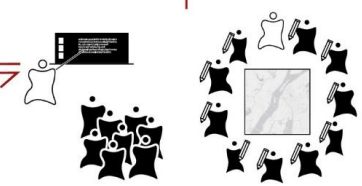
strategy

Implementation plan
Implementation Plan for the Renovation of Old Urban Residential Communities in Nanchang City, 2022

improve

improve

apply to



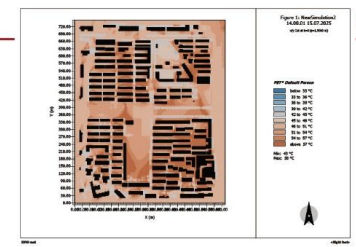
Participatory design

Design by expert

Technical guidance
Technical Guidelines for the Renovation of Older Residential Communities in Jiangxi Province

contribute to

contribute to



thermal performance evaluation

Acceptance and evaluation

Evaluation Indicators for the Renovation of Old Residential Communities

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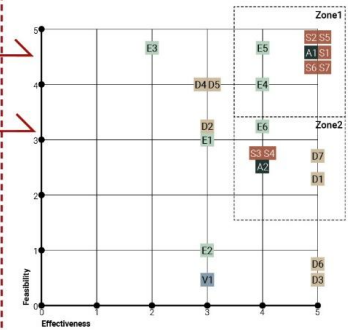
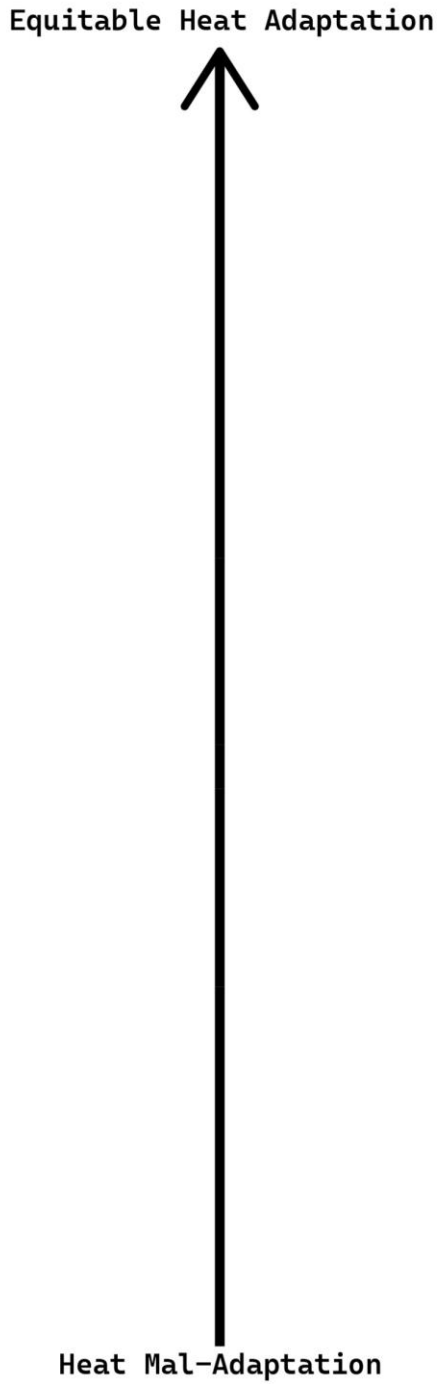


Recommendation matrix

6. Conclusion

Conceptual Framework

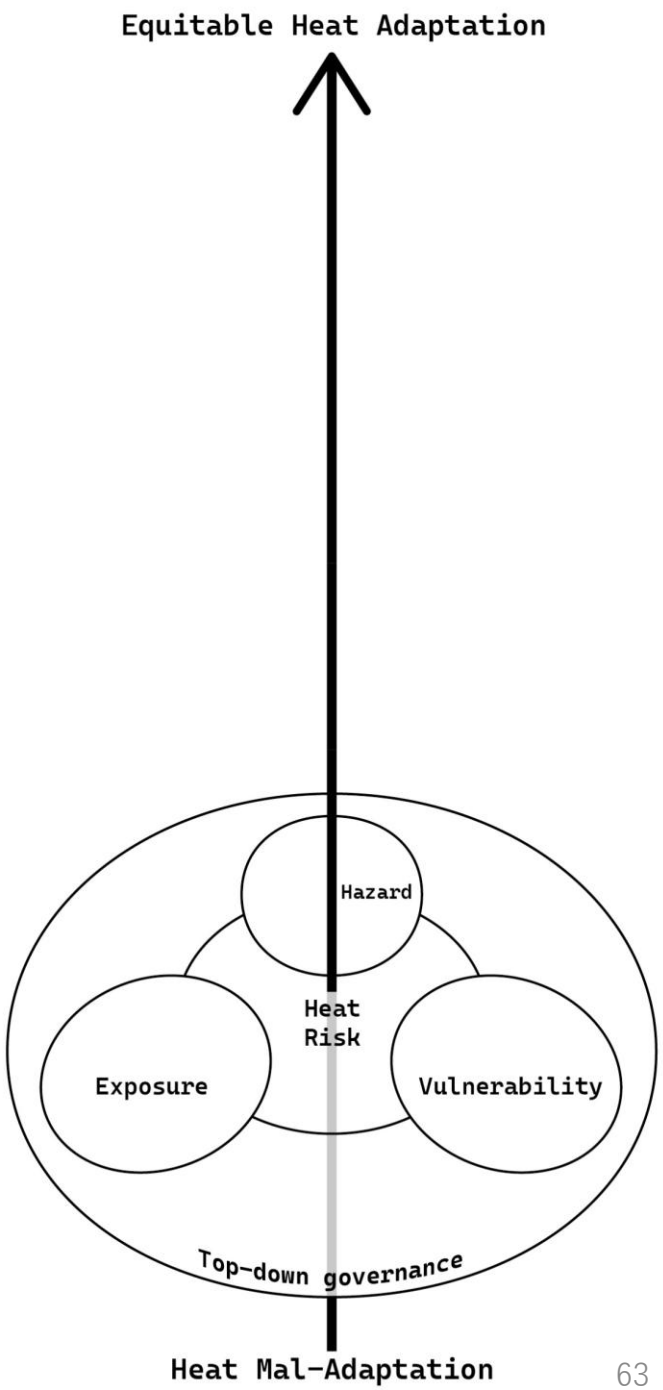


This framework serves as a **guiding structure** for the **transition from heat maladaptation toward equitable heat adaptation**.

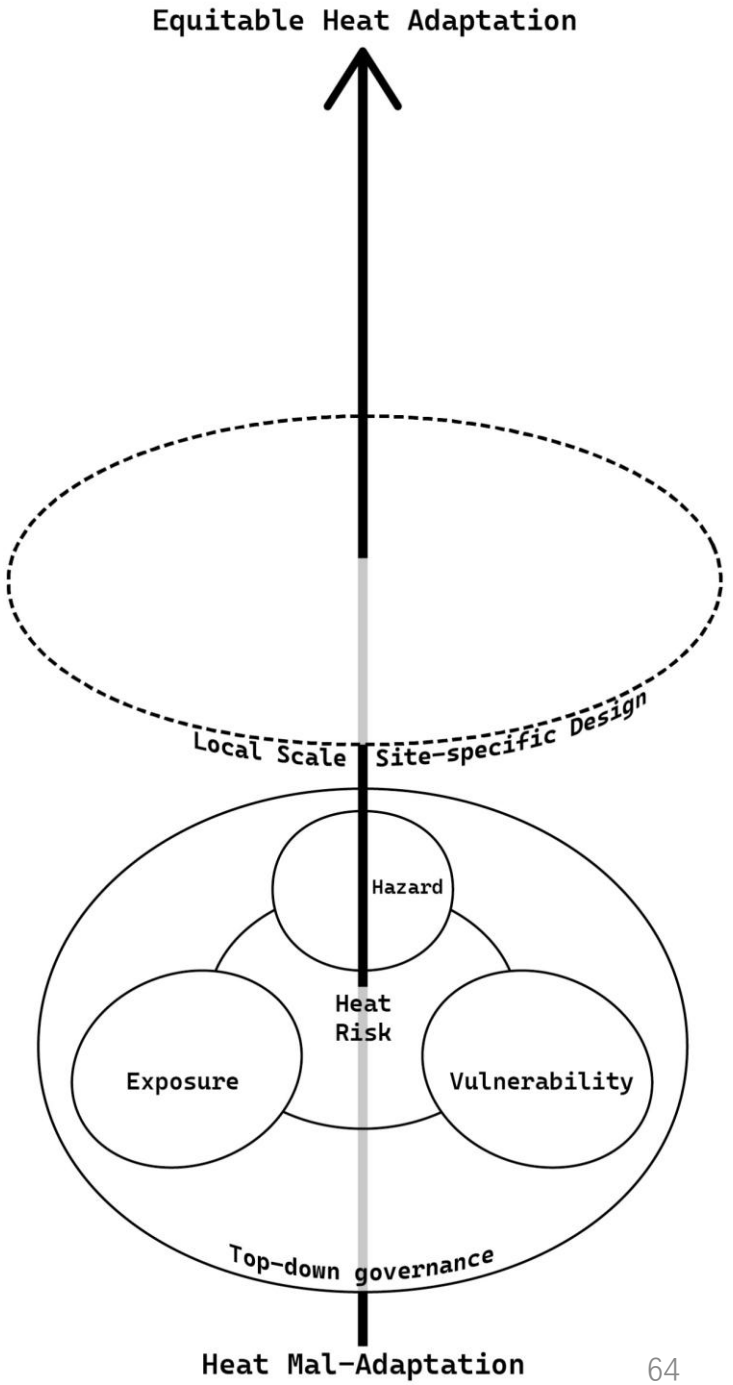
Conceptual Framework

As identified in the problem statement, existing heat adaptation in Nanchang is **constrained by a top-down governance approach that systematically overlooks heat risk mitigation.**

Accordingly, **governance method and heat risk** are positioned in the first layer of the framework as two overarching dimensions that **shape the entire adaptation process.**

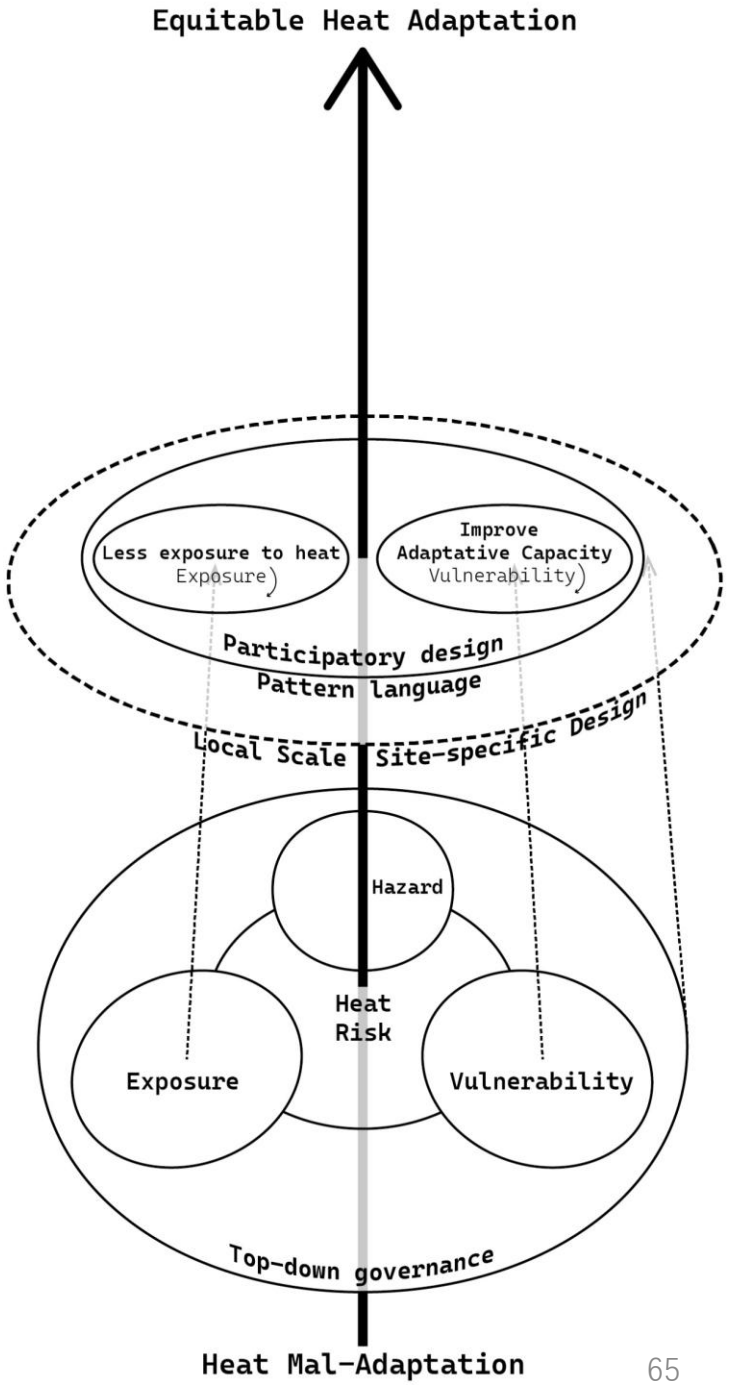


Conceptual Framework



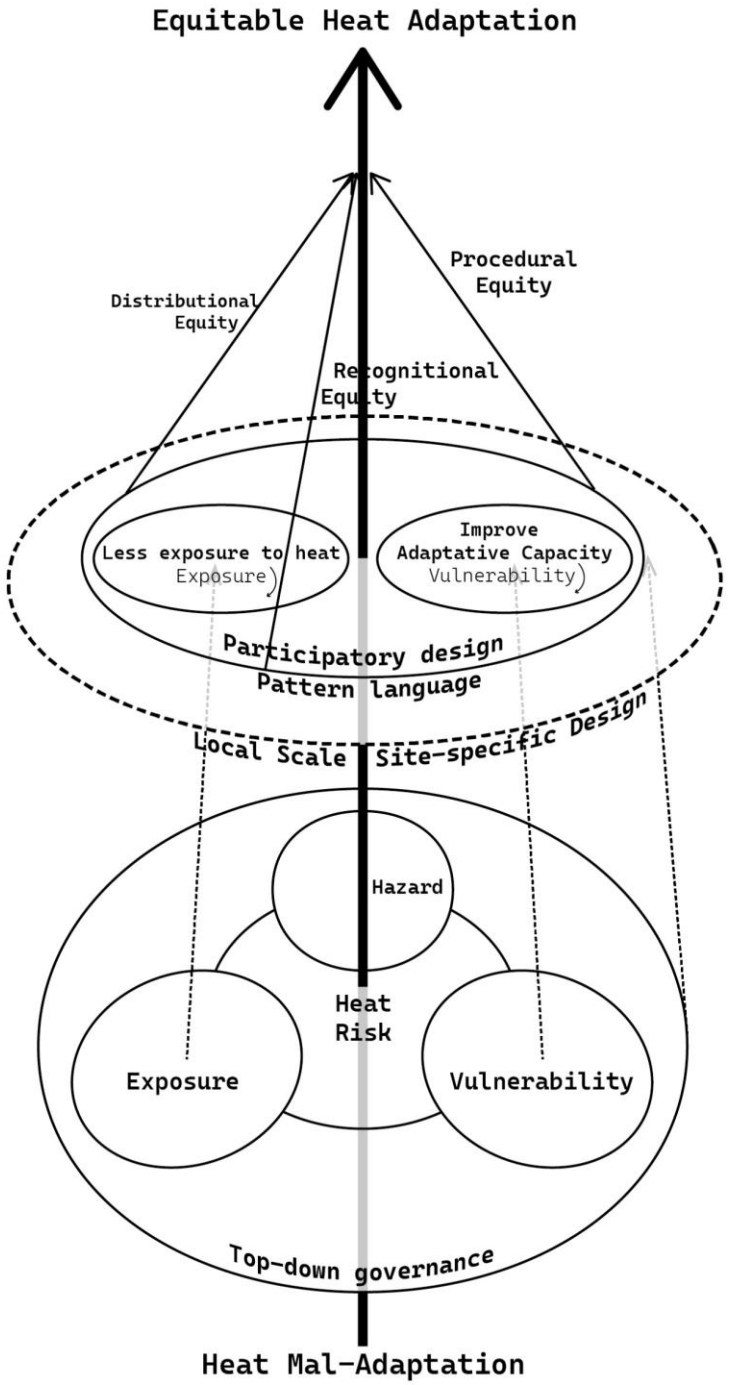
The second layer emphasizes **site-specific, local-scale design**, an area that is largely **absent from existing government planning.**

Conceptual Framework



Through integrating **pattern language** into a **participatory design** process, this project aims to **reduce heat exposure and vulnerability** at the local scale.

Conceptual Framework



Towards Procedural Equity
By integrating the heat-risk mitigation demands into **governance** and management.

Towards Distributional Equity
By implementing site-specific design into heat adaptation.

Towards Recognitional Equity
By valuing **residents' demand and proposals** of heat stress mitigation.

Thank you.