



Designing **Heat** Refuges

for the Dutch Elderly

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0 CONTENT



People cool off next to the fountains at the Louvre Museum in Paris on July 24, 2019, (AP Photo/Rafael Yaghobzadeh), Source: <https://mainichi.jp/english/articles/20190726/p2g/00m/0in/052000c>

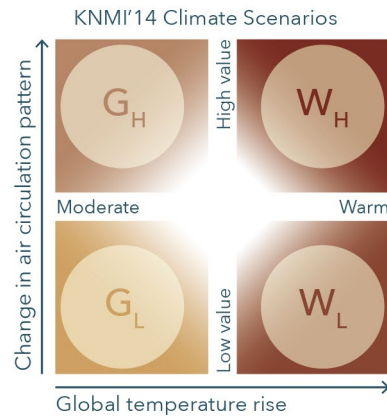
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1 THE ISSUE

What is the topic? & Why has the topic been chosen?

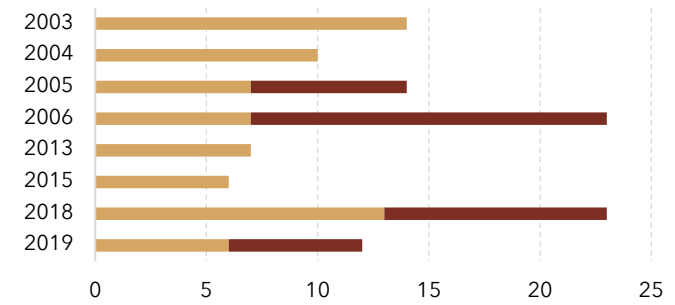
Sub-Q | BACKGROUND

Climate Change



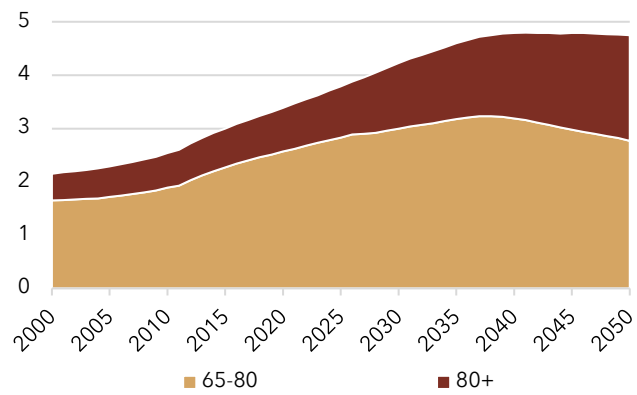
Four scenarios are used to predict the climate change in the Netherlands by KNMI. (Attema et al., 2014).
Reproduced by author.

Heat waves



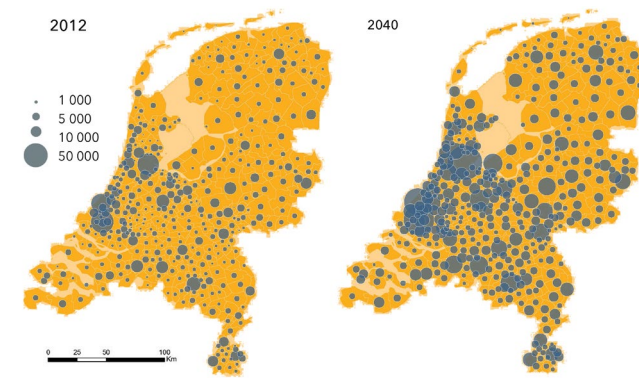
Recorded heat waves (days) in the Netherlands since 21st century (KNMI, 2019).

Ageing Population



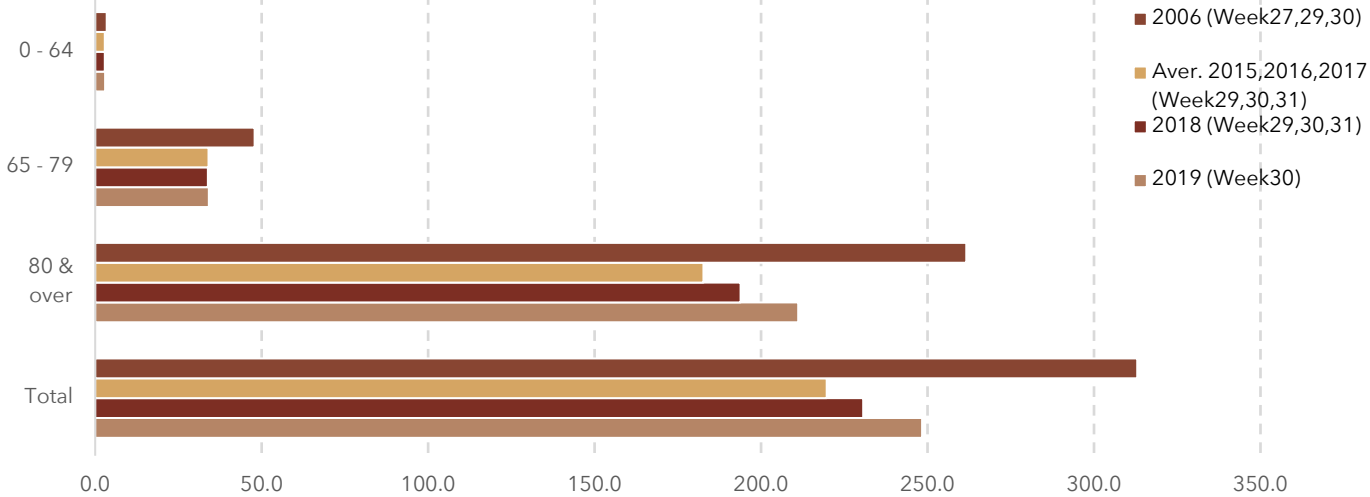
Current and predicted amount of the elderly (in million) in the Netherlands, by CBS (CBS, 2019b).

Concentration of the Elderly



The prediction of the concentration of the elderly in the Netherlands (PBL, 2014).

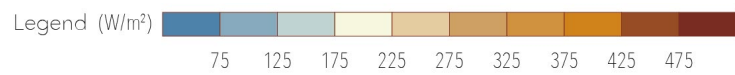
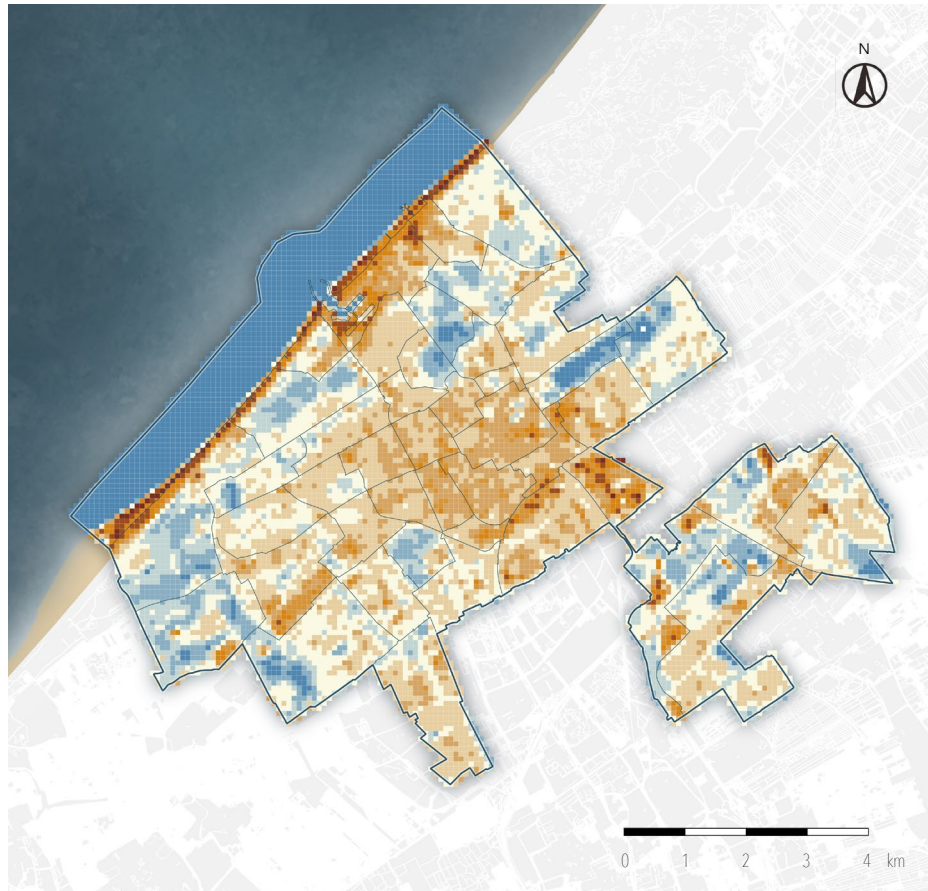
Heat-related Mortality



The death in different age groups during same period with heat wave in 2006, 2018 & 2019/death per 100 thousand inhabitants per week (CBS, 2019a).

1 THE ISSUE

Uneven Distribution of the Heat among the Public



Uneven Distribution of the Heat among the Elderly

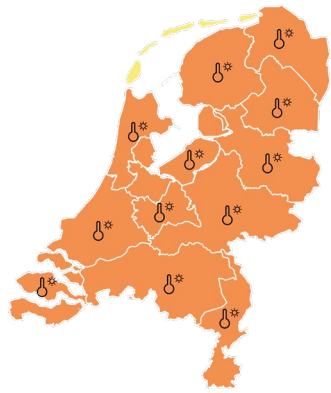


2 SCOPE

What are the current responses? & What are the proposed approaches in the thesis?

2 SCOPE

Public Health - National Heat Plan



Code orange is issued when temperatures in the Netherlands reach above 30°C for three days in a row and temperatures don't cool down past 18C during the night. (Mina Solanki, 2018).

Urban Planning - Mitigation & Adaption

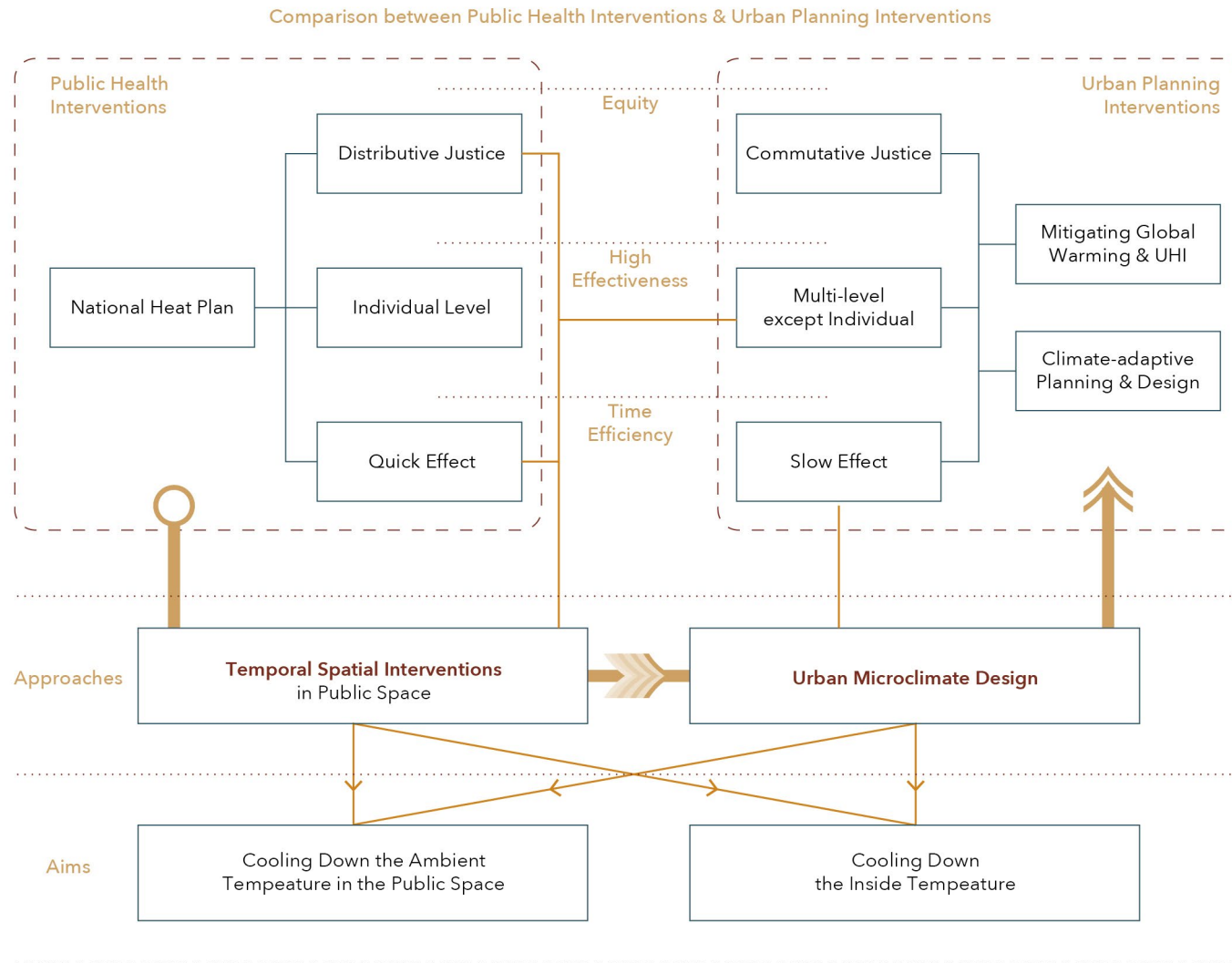


Heat roundabout in Zuid Holland (Provincie Zuid-Holland, 2019).



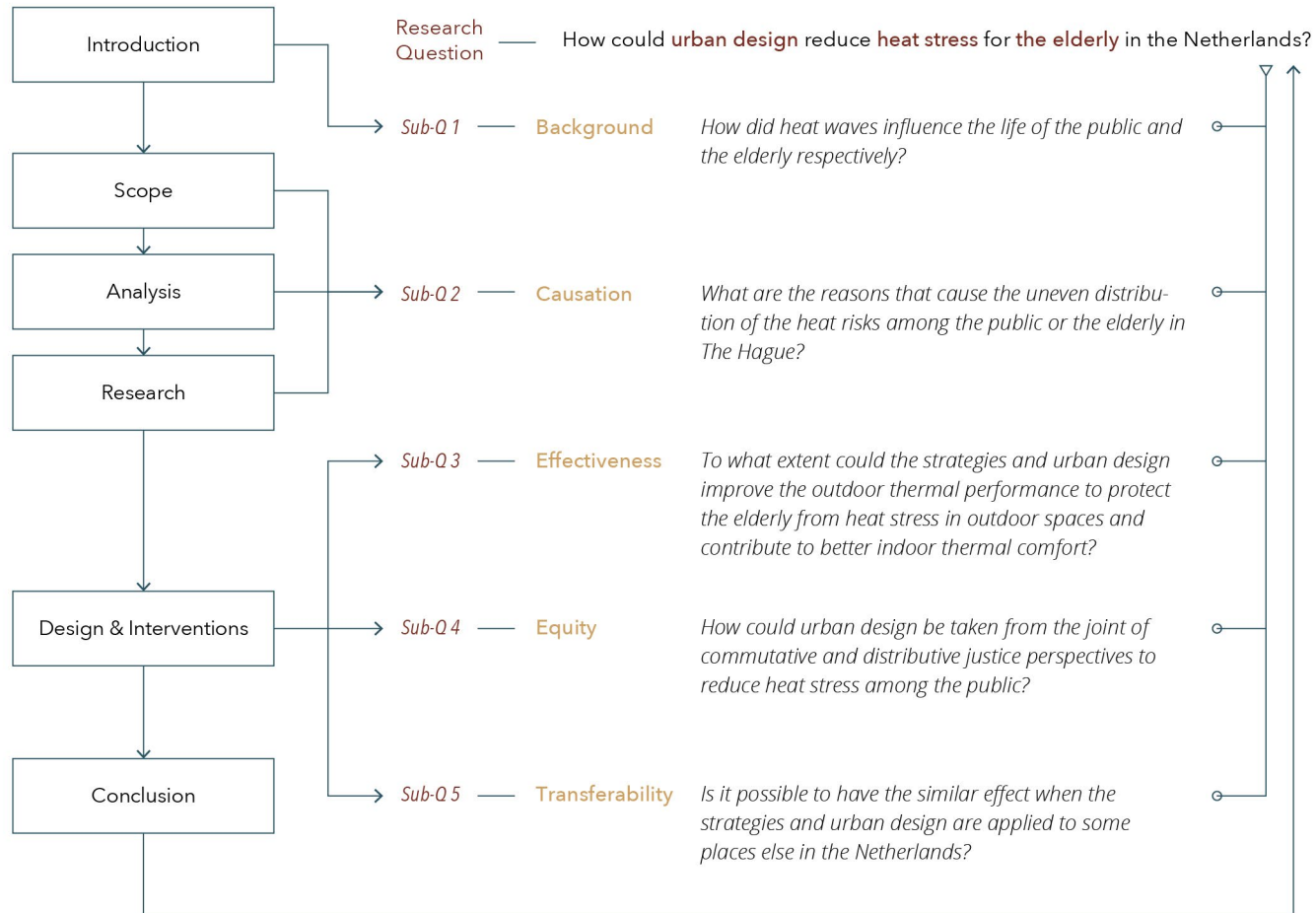
Rainproof strategies in Amsterdam (Amsterdam Rainproof, 2019).

2 SCOPE



- Comparison between public health interventions and urban planning interventions
- Proposed approaches to improve thermal performance to contribute to the transition from public health instructions to urban planning.
- Contribution to a livable city from the microclimate perspective.

2 SCOPE

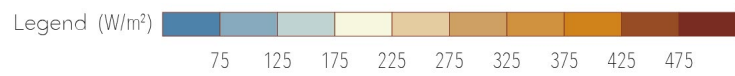
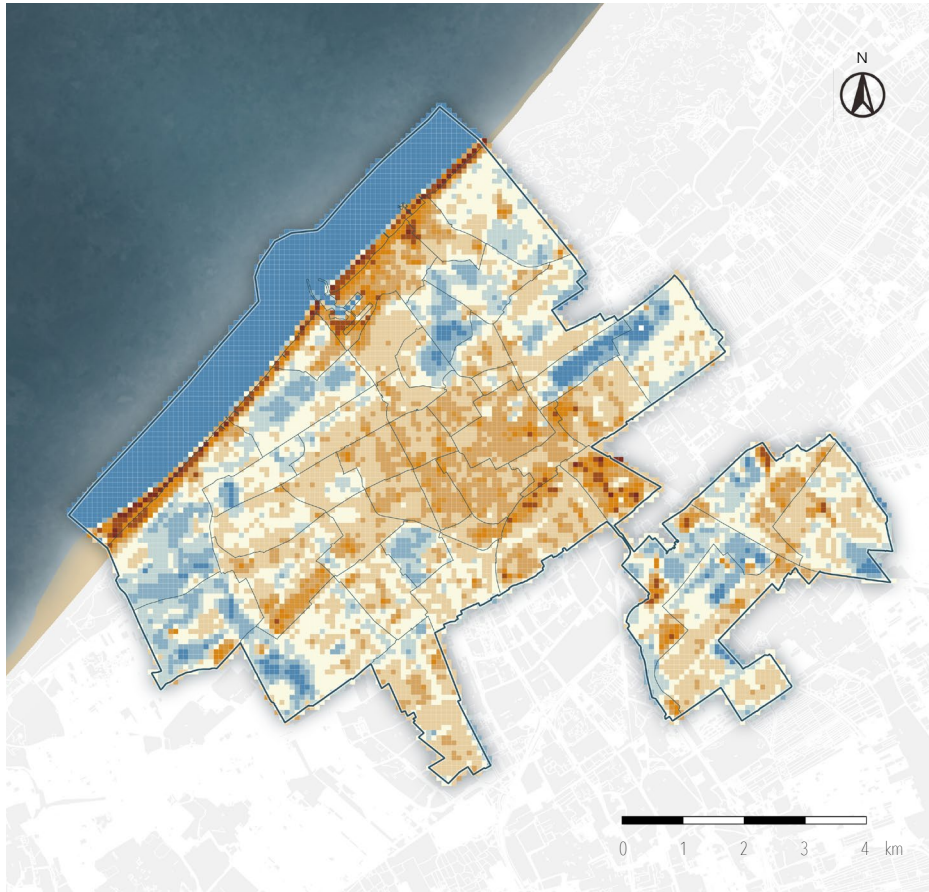


3 ANALYSIS

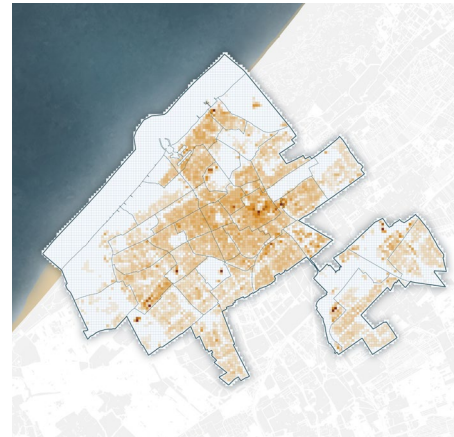
What are the factors that cause the uneven distribution of the heat risks among the public?

Sub-Q II CAUSATION

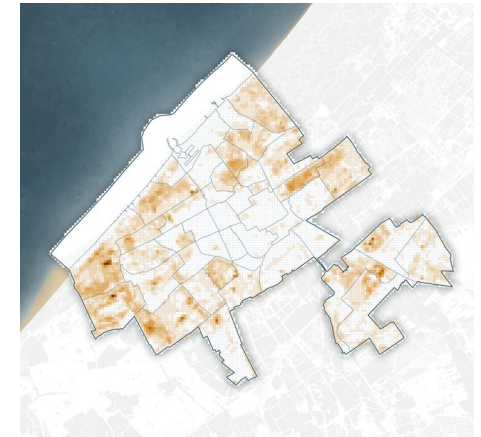
Surface Energy Balance



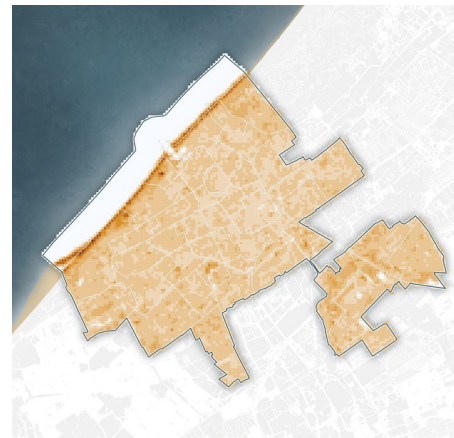
Ground Floor Index



Leaf Area Index



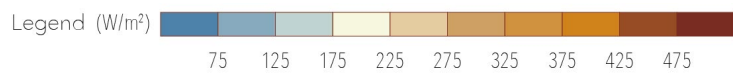
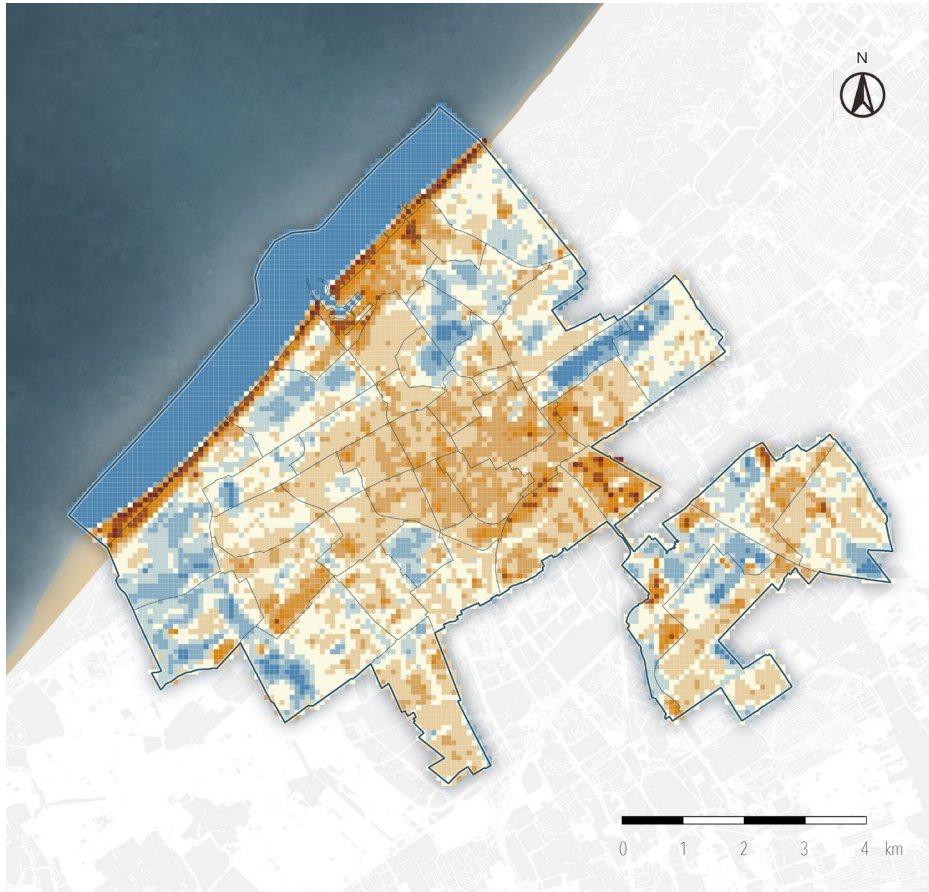
Albedo



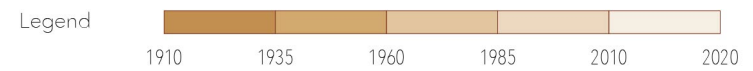
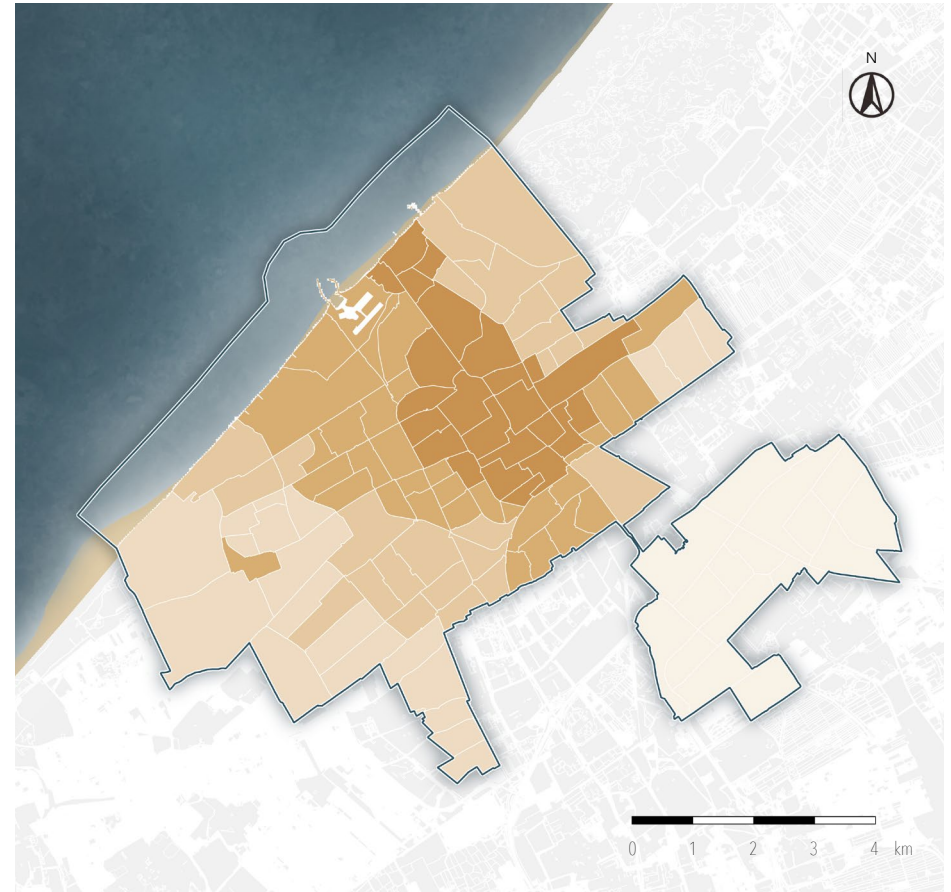
Surface Temperature



Surface Energy Balance



Historical Development Map of The Hague



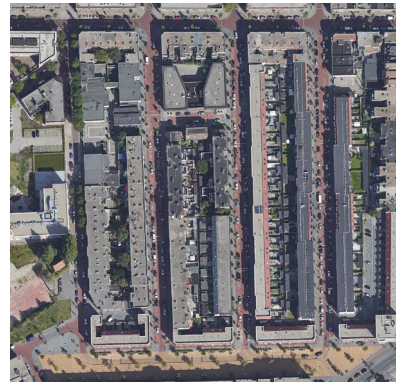
Dark-colored Roofs



Impervious Pavements



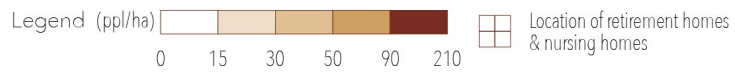
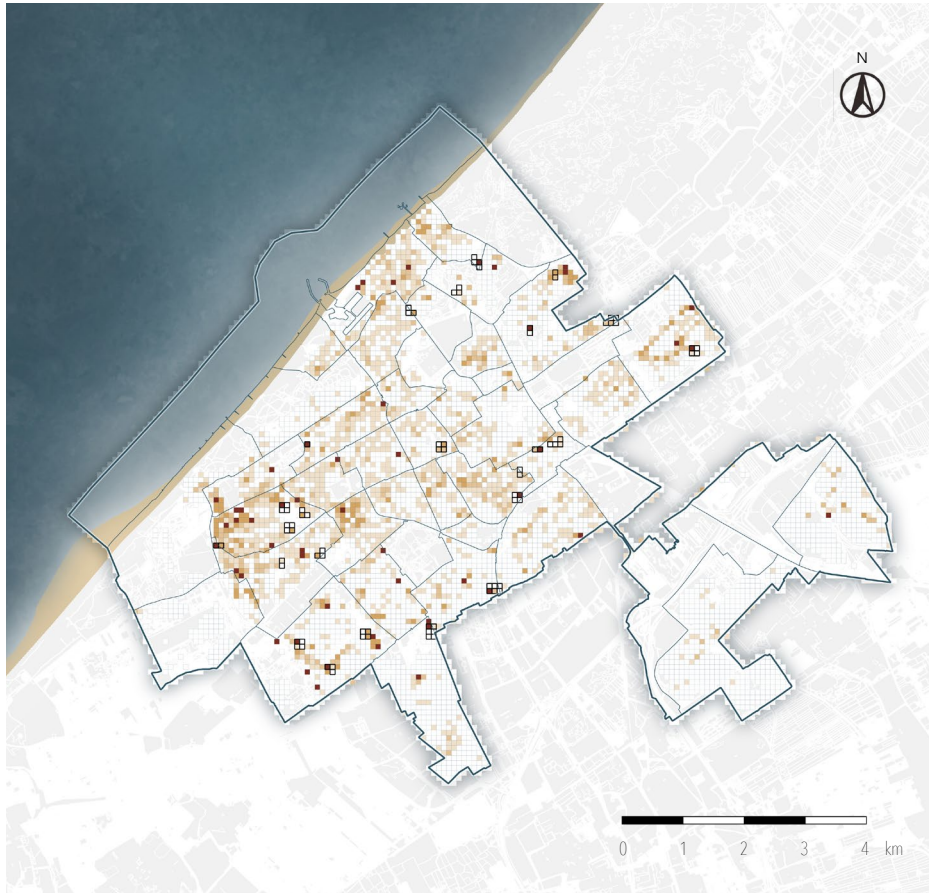
Less Vegetation & Water



Courtyard Dwellings



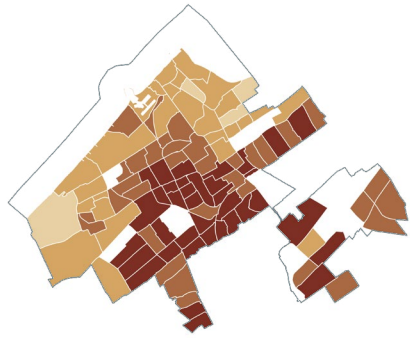
Concentration of the Elderly in The Hague



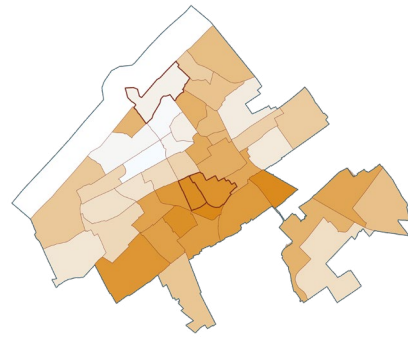
Intergrated Map of 'Heat' & 'The Elderly'



Indoor Temperature



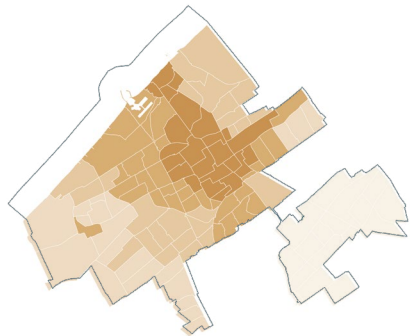
Neighborhood Dashboard



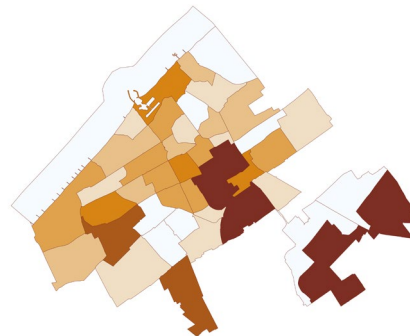
Decision on the Study Areas



Development of the Elderly

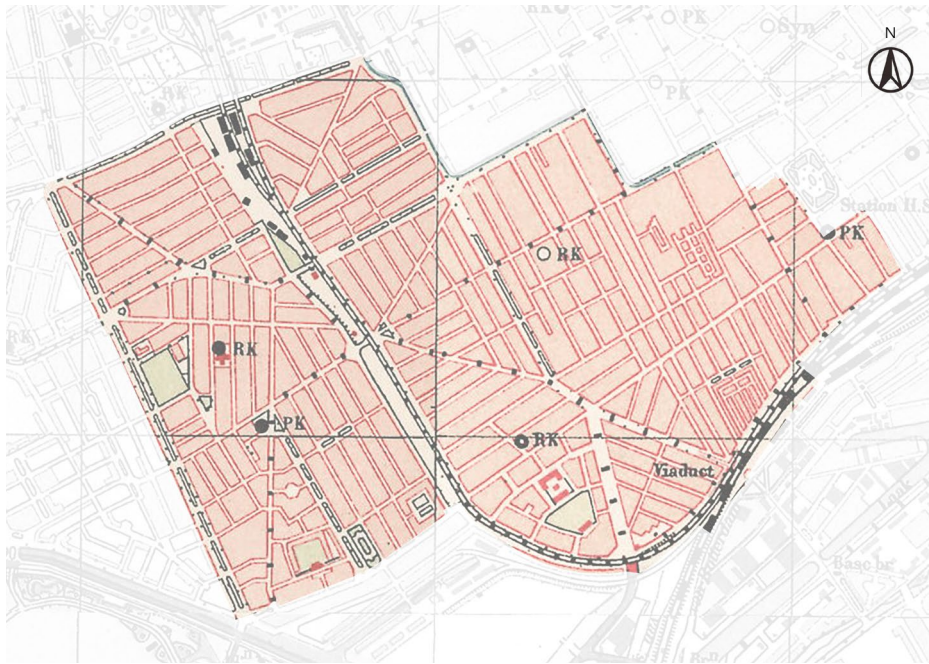


Prediction of the Elderly

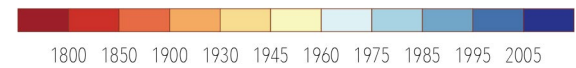


Schildersbuurt and Transvaalkwartier in 1940s

The Year of Construction of the Buildings in the Study Areas



Legend



Health and Lifestyle Figures for Each Neighborhood in NL by RIVM

	Schildersbuurt	Transvaalkwartier	The Hague	Netherlands
Population	31255	16160	519988	16979120
Good experience health	52%	57%	70%	75%
Long-term disorders	46%	42%	38%	35%
Risk of depression	68%	67%	52%	45%
High risk of depression	24%	22%	12%	7%
Physical limitation	37%	34%	20%	16%
Restriction on movement	29%	26%	14%	11%
Restriction in hearing	11%	11%	5%	5%
Restriction in seeing	19%	17%	9%	6%
Loneliness	65%	65%	53%	44%
Severe loneliness	25%	24%	16%	10%

Analysis from Spatial Perspective



- Legend
- Open Space
 - Vegetation
 - Water body
 - Buildings in sites
 - 5 mins walking from O.S.

. *Analysis of open spaces and covering range in the study areas*

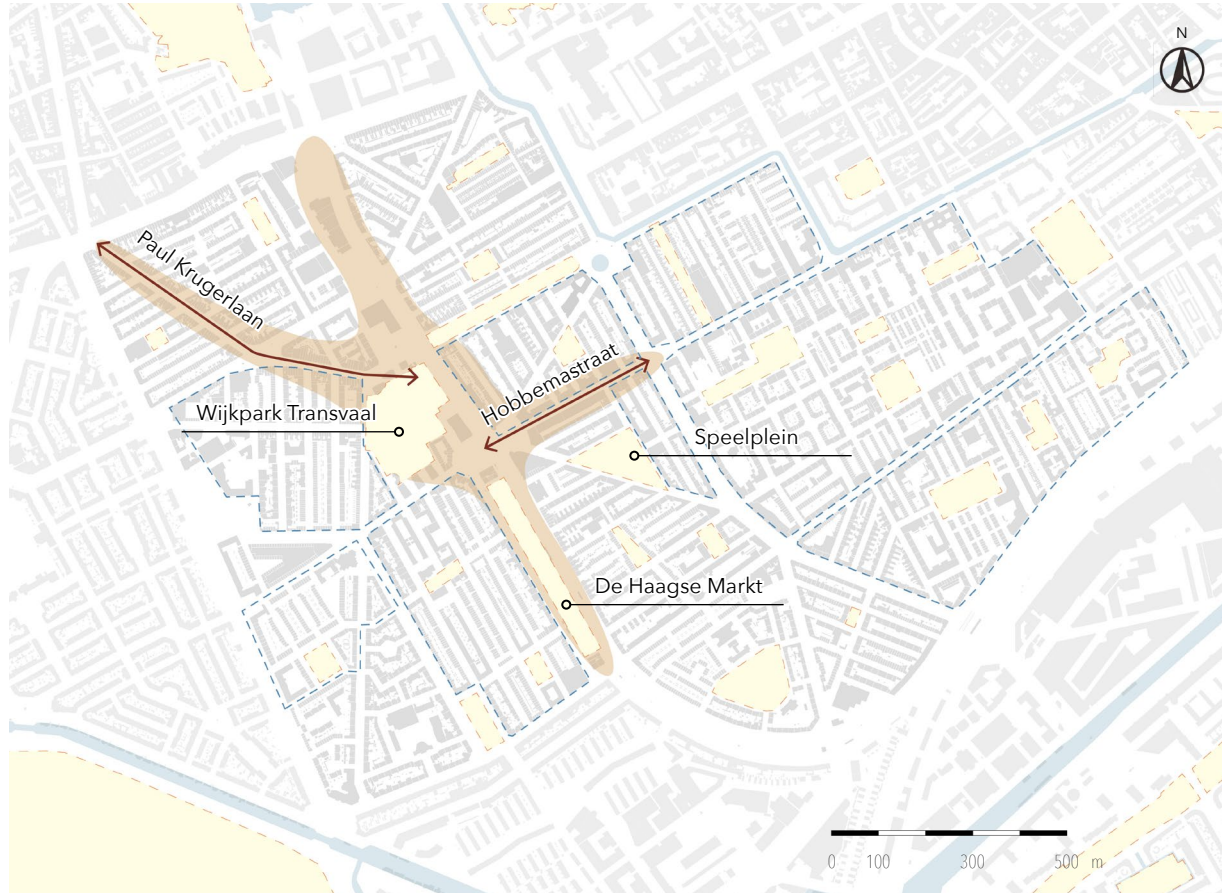
Analysis from Microclimate Perspective



- Legend
- Buildings with orientations that cause high risk

. *Analysis of building risks from the perspectives of facade orientation*

Conclusion of Analysis on the Study Areas



- Legend
-  Open space
 -  Relatively public areas
 -  Residential clusters with high risks of high indoor temperature
 -  Streets with retails, food and beverage

Places with Relatively Public Functions



Satellite images of Wijkpark Transvaal



Street view of the street Hobbemastraat

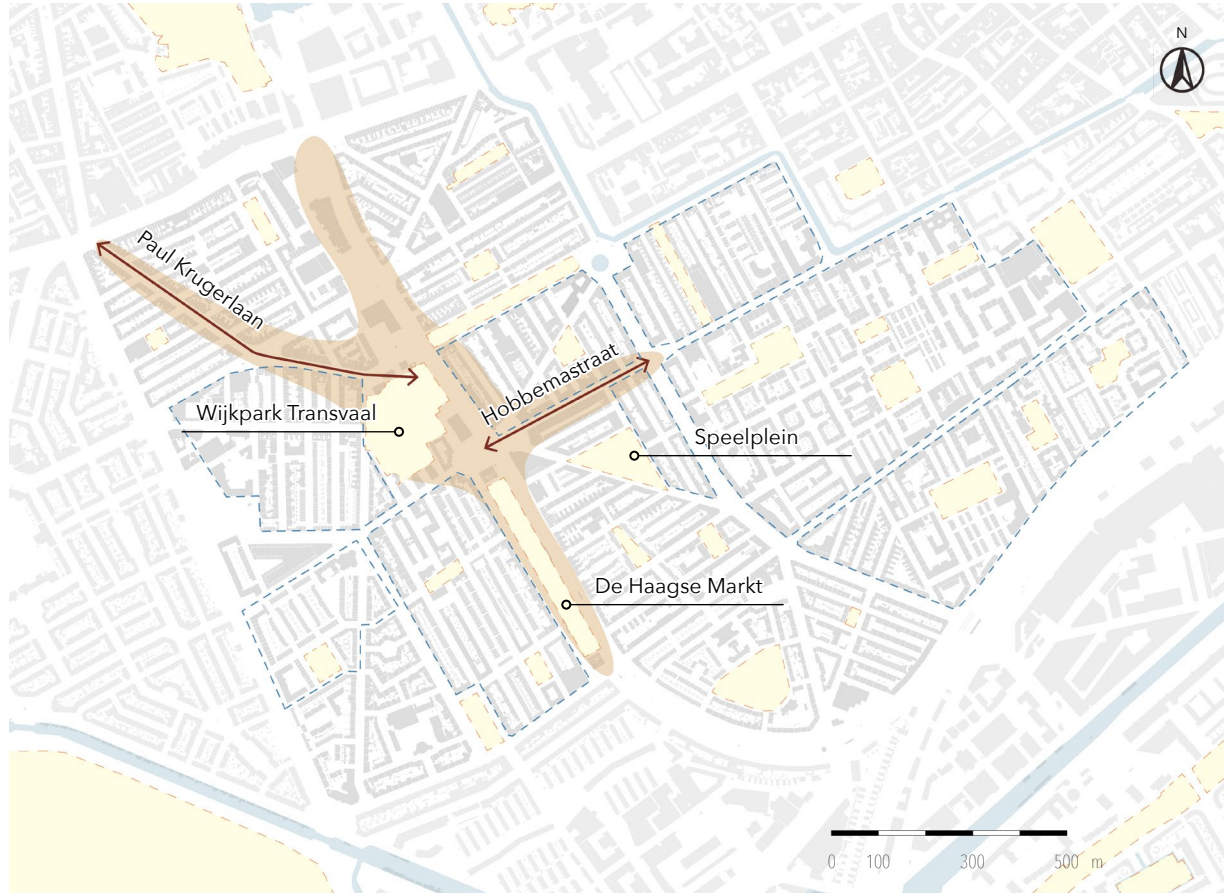


Satellite images of Speelplein



Street view of the street Paul Krugerlaan.

Focusing on the Places inside Residential Areas



- Legend
- Open space
- Relatively public areas
- Residential clusters with high risks of high indoor temperature
- Streets with retails, food and beverage

4 RESEARCH

What are the effects of building typology on microclimate? & What are the possible solutions to improve outdoor thermal comfort?

Sub-Q II CAUSATION

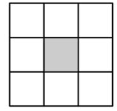
4 RESEARCH

Research for Design

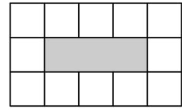
Typology Study on Courtyard Dwellings
The Effect of Vegetations on Microclimate
Prevailing Wind during Heat Waves

Research by Design

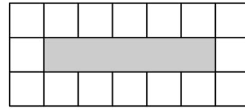
Spatial Interventions on Courtyard Dwellings



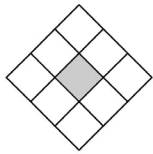
10x10_W-E (N-S)



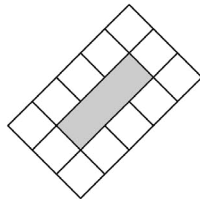
10x30_W-E



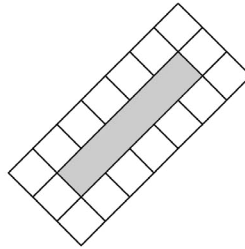
10x50_W-E



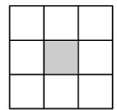
10x10_NE-SW



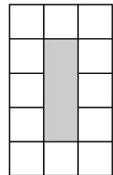
10x30_NE-SW



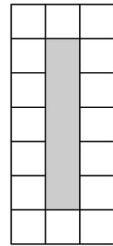
10x50_NE-SW



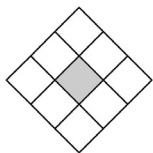
10x10_N-S



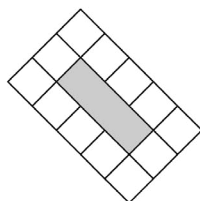
10x30_N-S



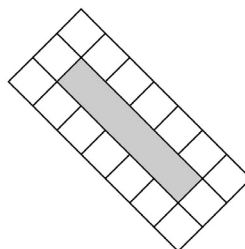
10x50_N-S



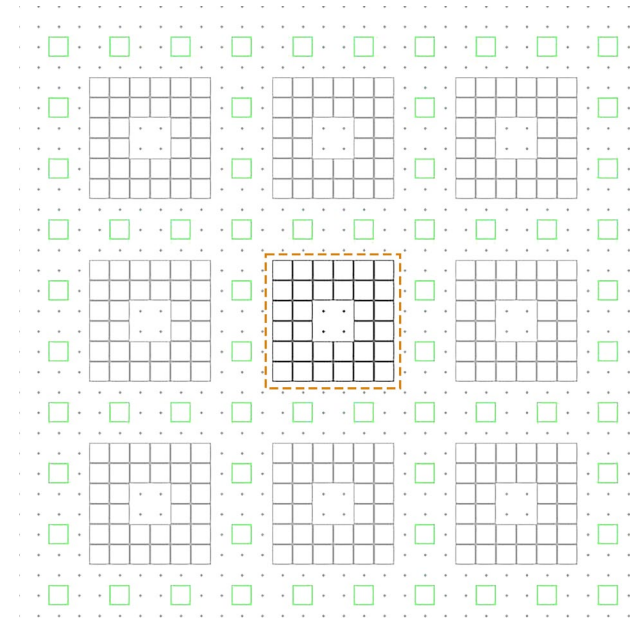
10x10_NW-SE (NE-SW)



10x30_NW-SE

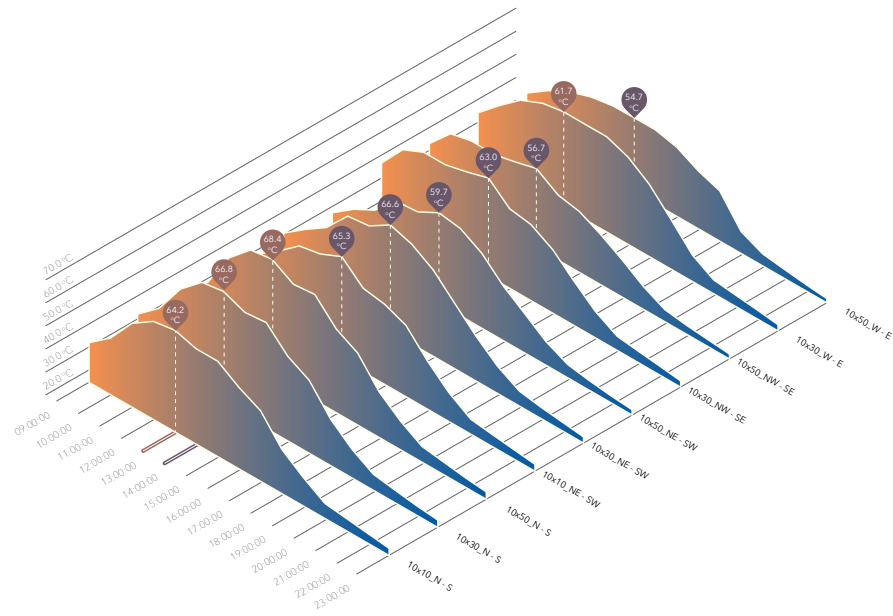


10x50_NW-SE



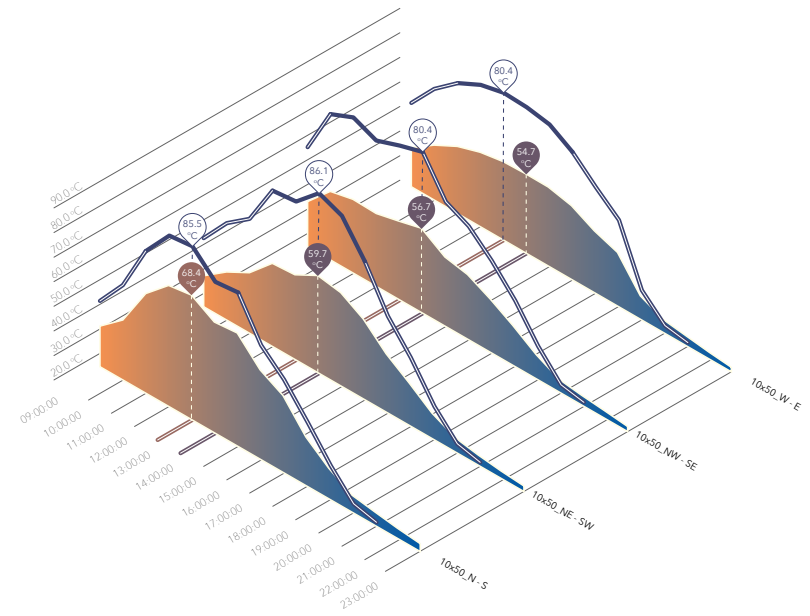
The average value of all the grids in the courtyard of the block in the center has been calculated.

Impact of Different Length along the Orientation



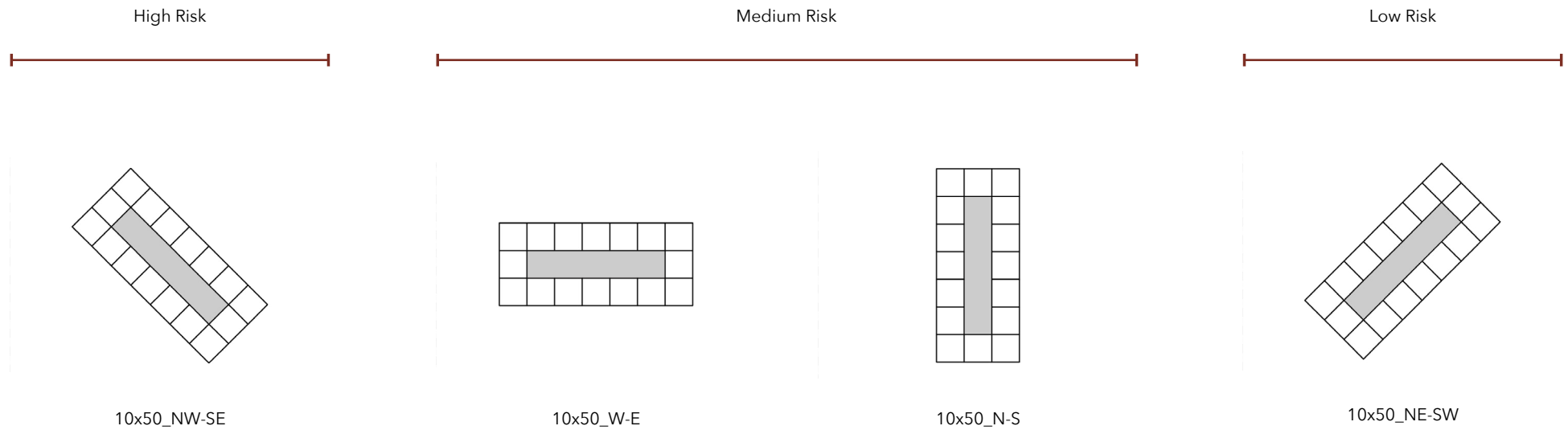
Layered area chart for the trend of the average values of PET among the grids in each model.

Impact of Different Orientation along the Canyon Axis



Layered area chart for PET & MRT of 4 selected models

Evaluation of Risks among Studied Typologies from the Perspectives of Orientation



- According to the research on the typology of courtyard dwellings and the assumption that the elderly or citizens follow the instruction from the municipality that they go out for activities in the morning or at night and stay at home during noon and afternoon, the typology with different orientation could be divided into some categories with different risks level.

Evaluation of Risks among Courtyard Dwellings from the Perspectives of Orientation



Legend ■ Building blocks with high risks ■ Building blocks with medium risks ■ Building blocks with low risks

Grass



Source: <https://homeguides.sfgate.com/difference-between-deciduous-coniferous-72832.html>

Trees



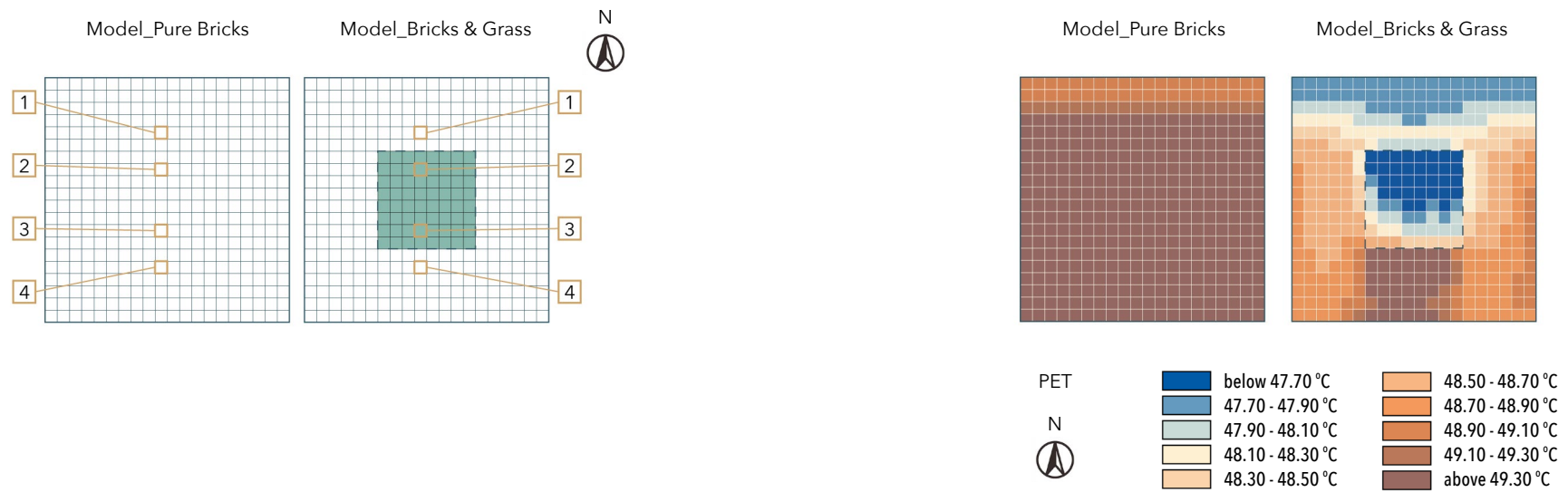
Source: <https://www.indiamart.com/prod-detail/hedge-plant-13547002855.html>

Hedges



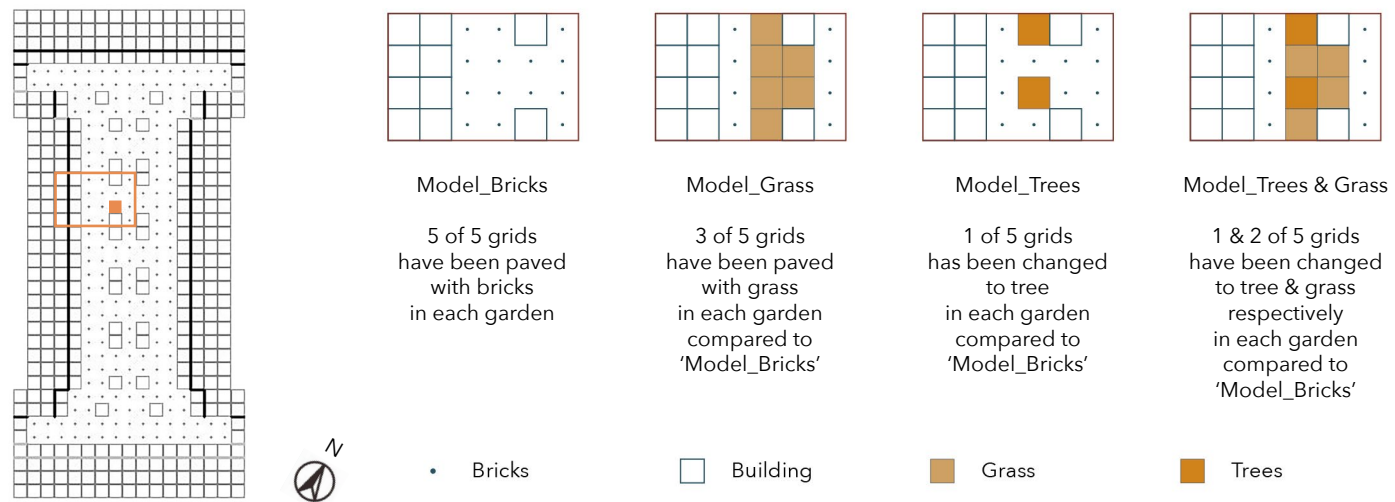
Source: <https://www.lovethegarden.com/uk-en/article/complete-guide-lawn-and-grass-feeding>

Test of the Effect of Grass on Microclimate



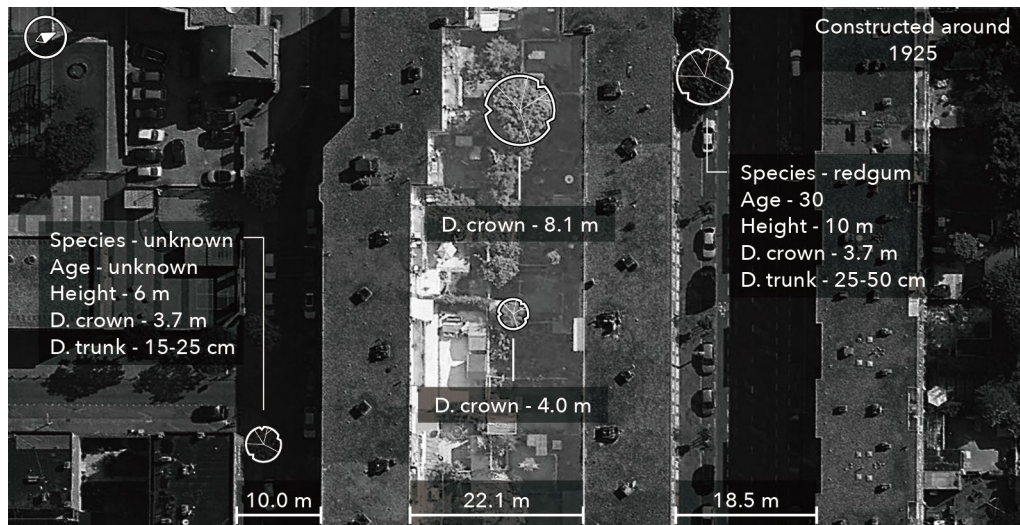
The values of air temperature and PET at 1.5-meter height have been collected and analyzed.

The Effect of Trees & Grass on Microclimate in the Courtyards



The application of grass, trees and the combination of grass and trees in a conceptual courtyard block dwellings to compare the effect of vegetations on microclimate.

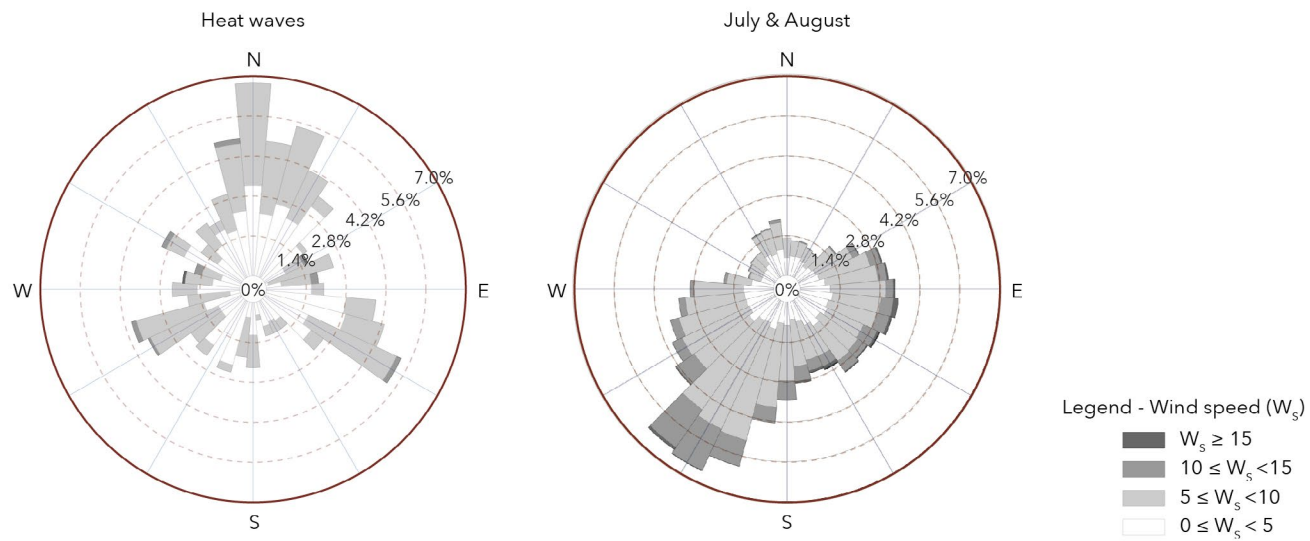
Mapping of Trees' Growing in The Hague



Courtyard block dwellings in the neighborhood Transvaalkwartier

- Vegetations usually have positive effect on the mitigation of urban heat island but from the perspective of outdoor thermal comfort on pedestrian level, the trees and grass are better choices than hedges and bushes.
- Planting trees from now on in a good location and arrangement.
- The combination of trees and grass could one of the best choices to improve thermal comfort in public spaces and courtyard.

Wind Roses of the Weather Data Measured at the Weather Station Hoek Van Holland

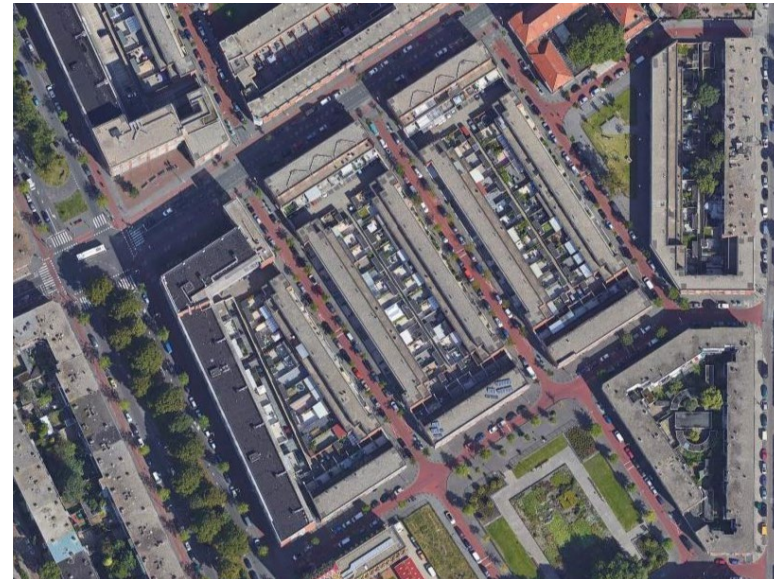


Wind direction and wind speed during heat waves were different from those during months with hot weathers

Selected Block for the Test of Spatial Interventions



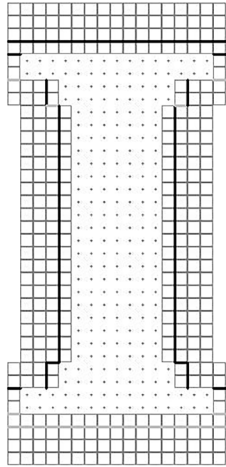
Location of selected block.



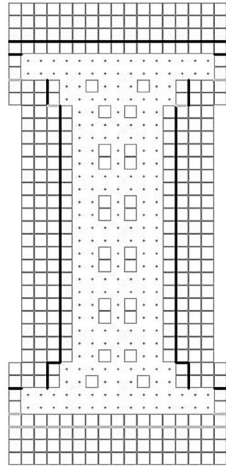
Satellite image of selected block.

Interventions inside Blocks to Compare the Difference between Spatial Interventions

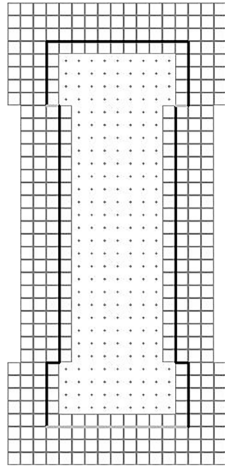
Model_Control group
Actual without storage



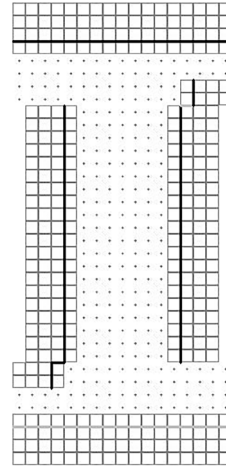
Model 1
Actual with storage



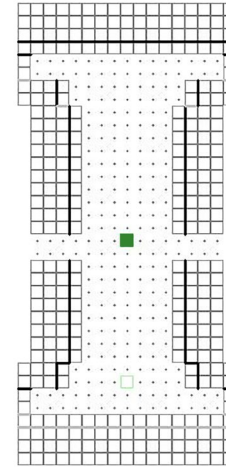
Model 2
Closed envelop



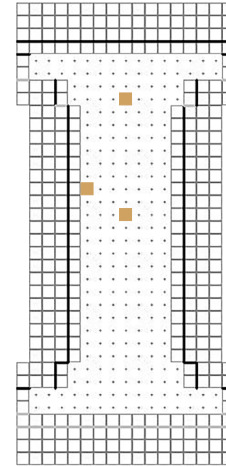
Model 3
Open around corners



Model 4
Open in the middle



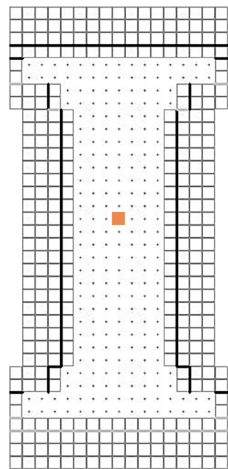
Selected Grids for
Comparison



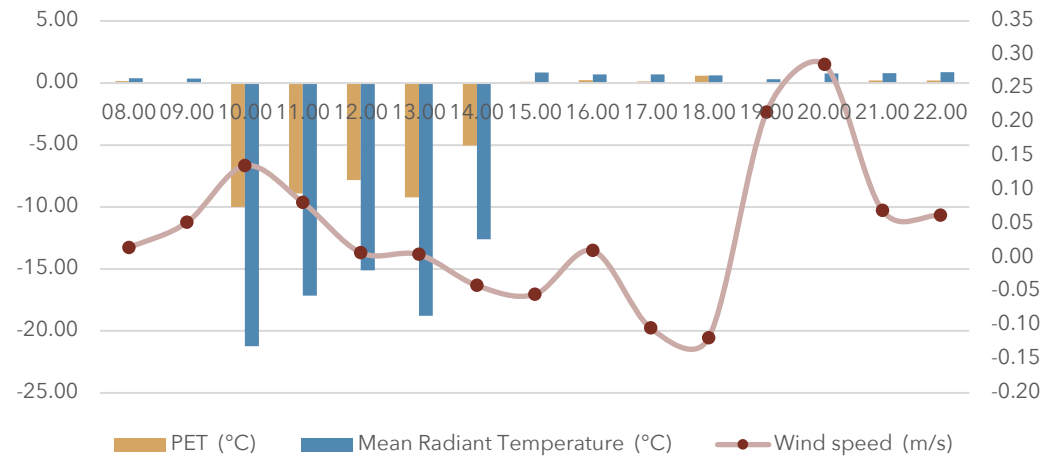
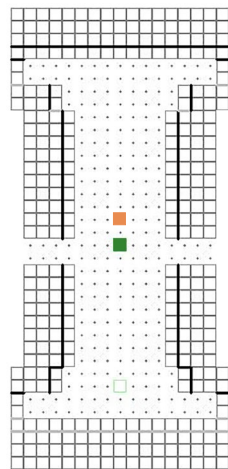
The comparison between 'Model_Control group' and the rest to learn about the spatial interventions on the envelopes of the courtyards.

A Game between Shading & Wind in Outdoor Spaces

Model_Control group
Actual without storage

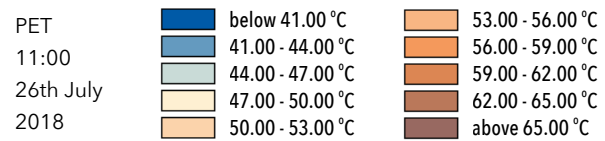
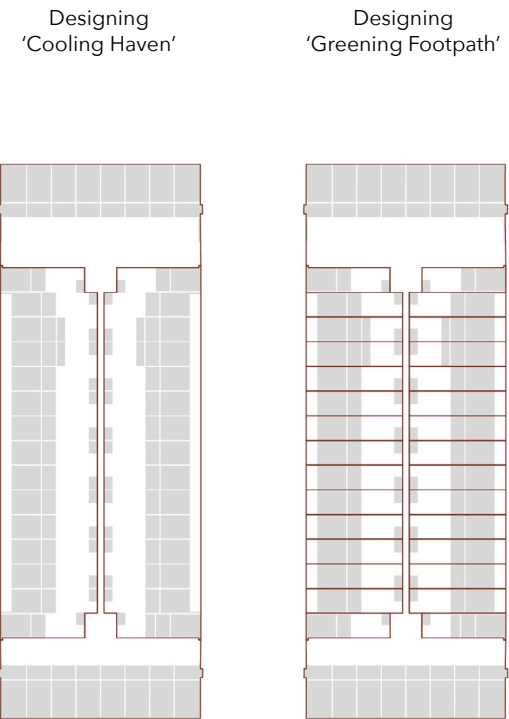
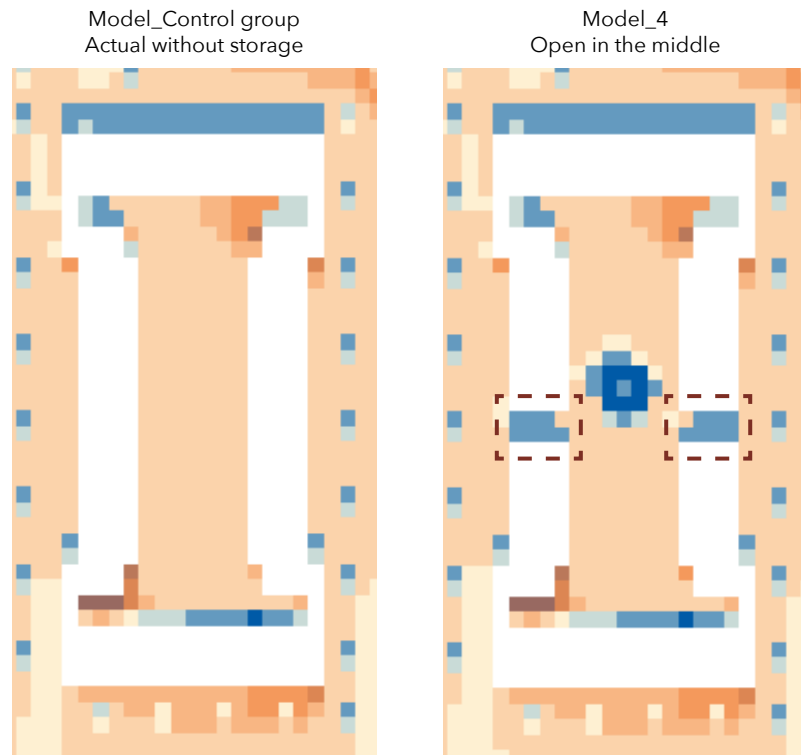


Model 4
Open in the middle



The comparison between 'Model_Control group' & 'Model 5 Open in the middle' as an example.

Inspiration of Designing 'Cooling Haven' & 'Greening Footpath' in the Courtyard

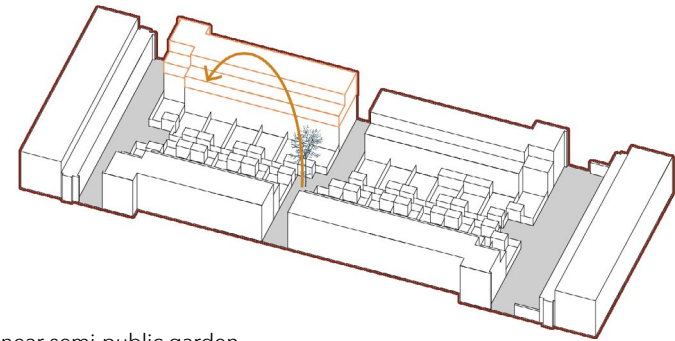
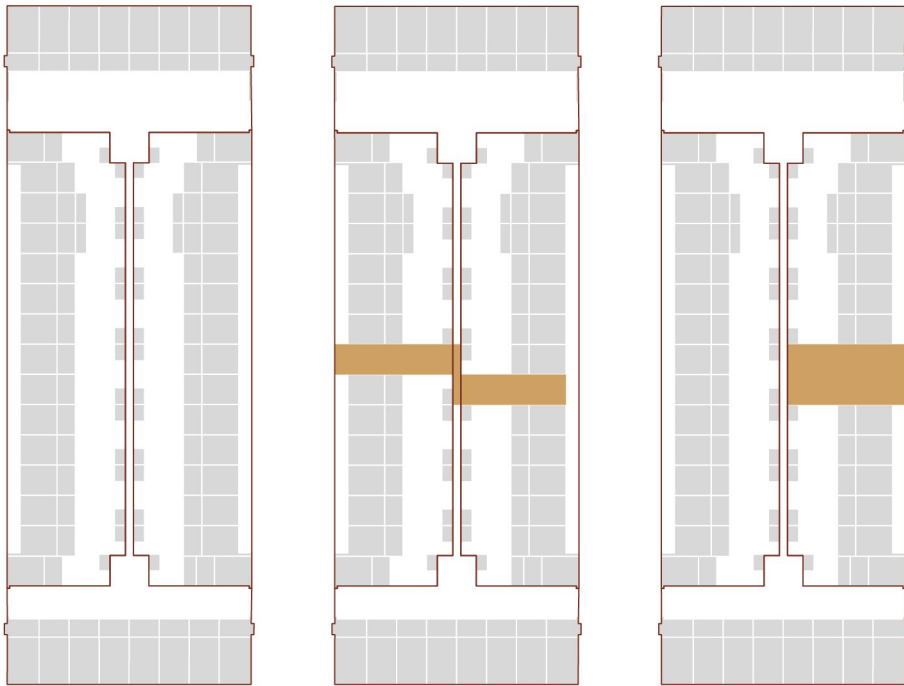


Strategies for different situations of different parcellation.

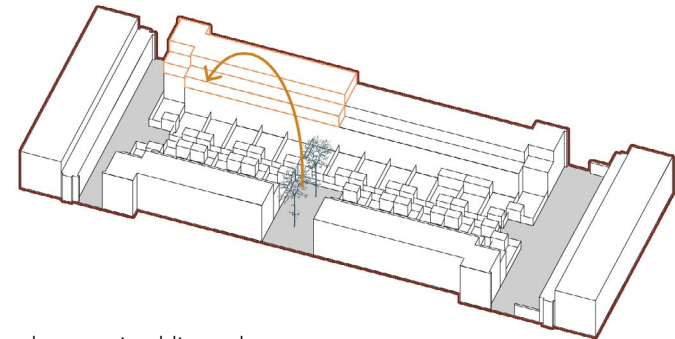
Designing 'Cooling Haven' in the Courtyards

Designing linear semi-public garden

Designing quadrate semi-public garden

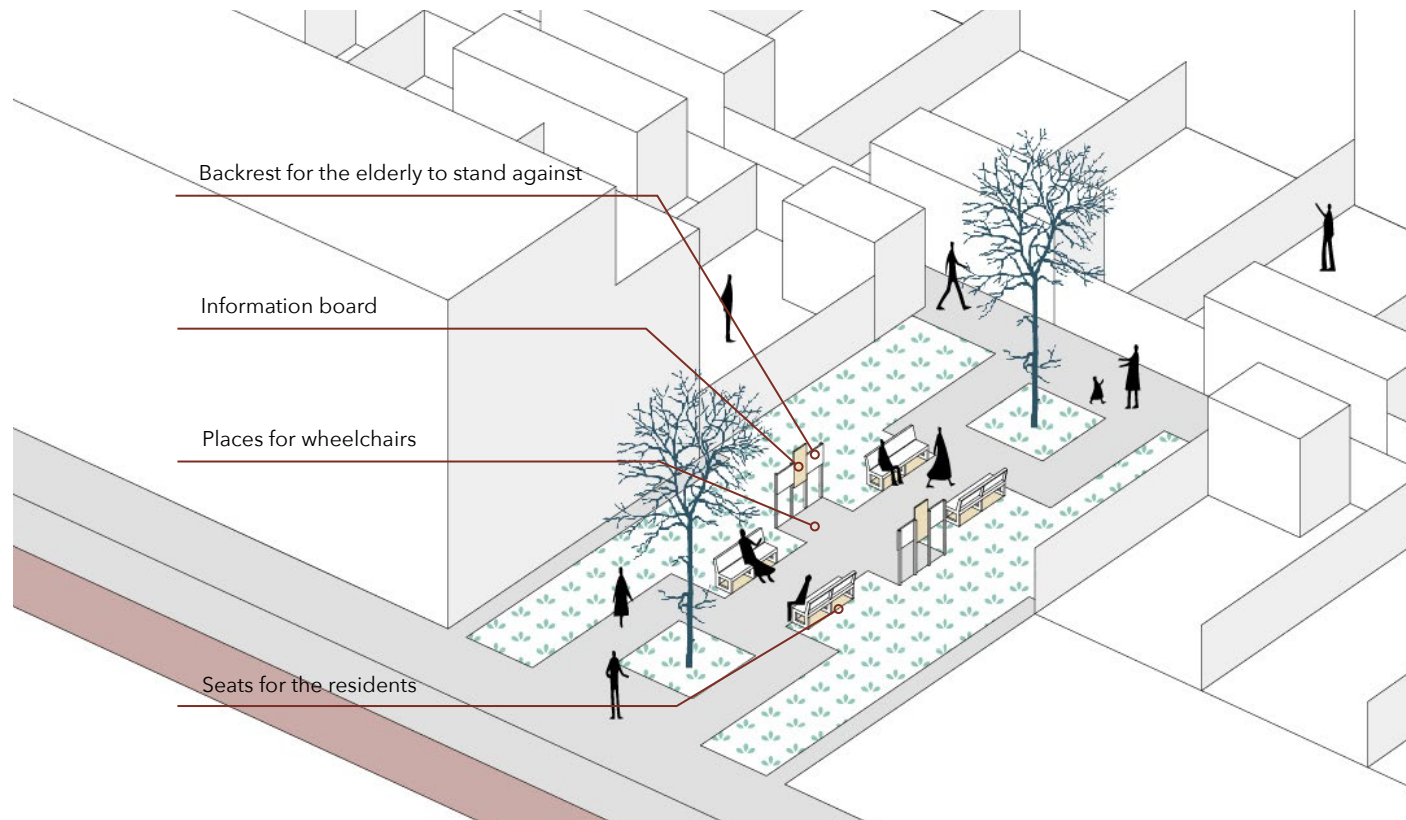


Linear semi-public garden

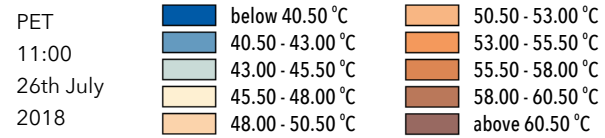
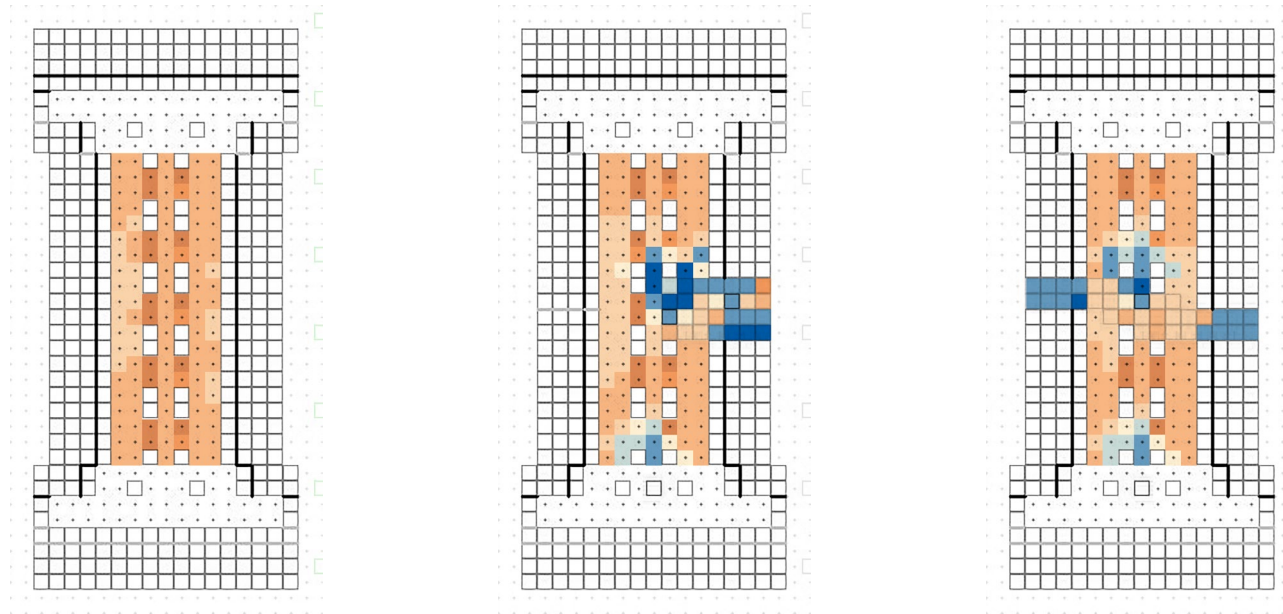


Quadrate semi-public garden

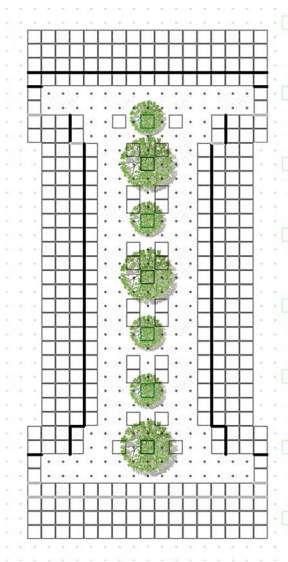
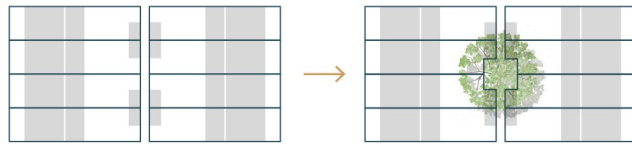
Designing of 'Cooling Haven' within the Block for Residents with More Consideration of the Demands from the Elderly



Improvement of Local Microclimate by Designing 'Cooling Haven'



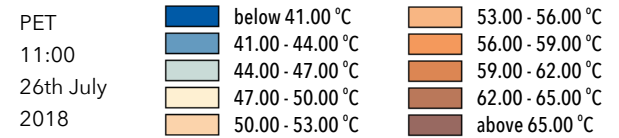
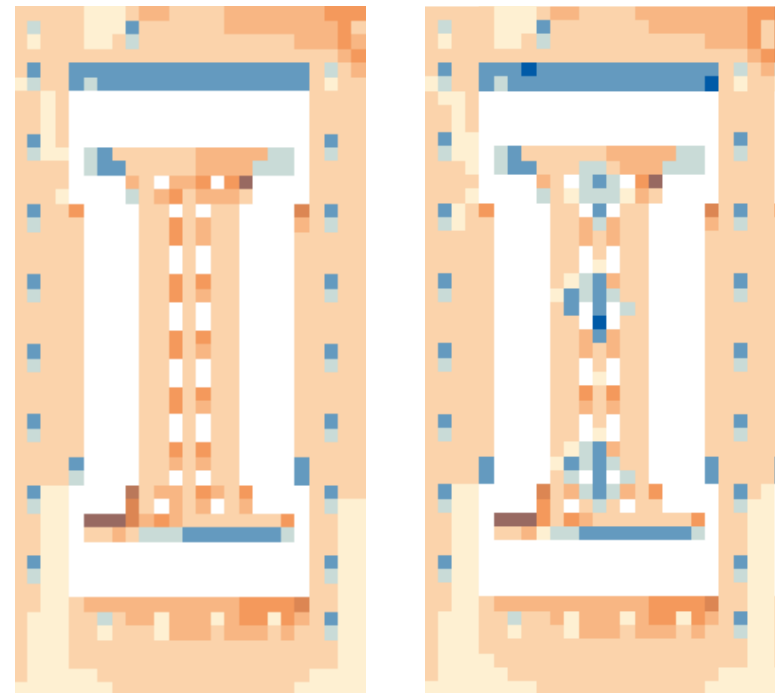
Designing 'Greening Footpath' in the Courtyard

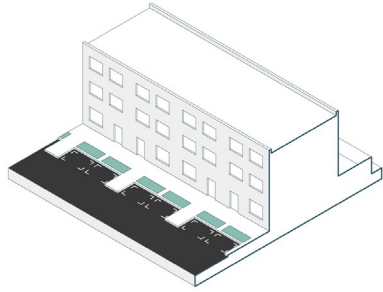


'Borrow' or 'exchange' land from residents to plant trees

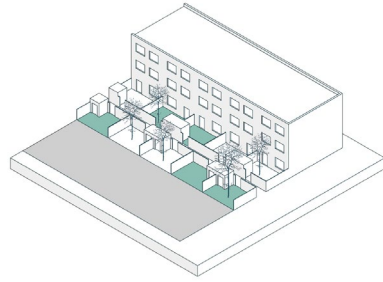
Before interventions

After interventions

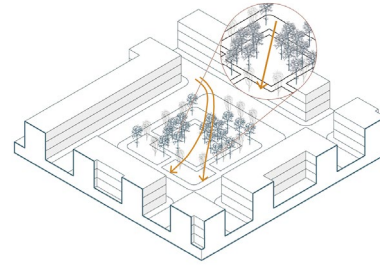




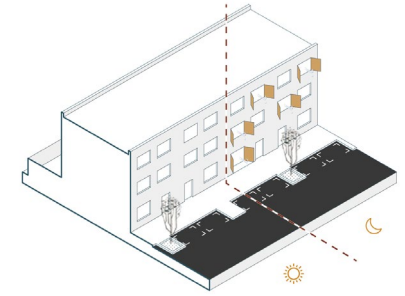
Replacing pavements with grass on public spaces



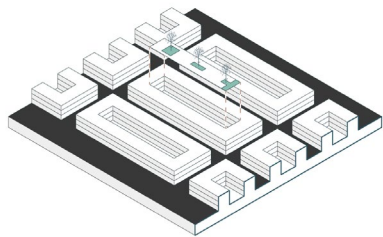
More vegetations inside the courtyards



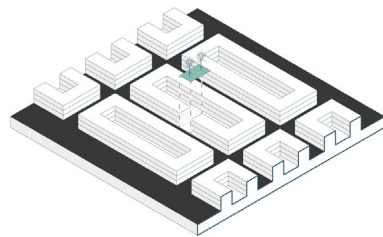
Planting trees as a cluster



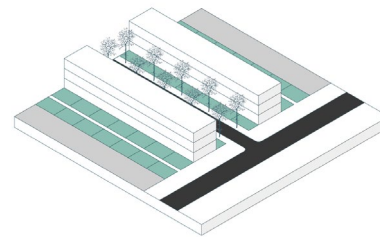
Smart choices of opening & closing windows



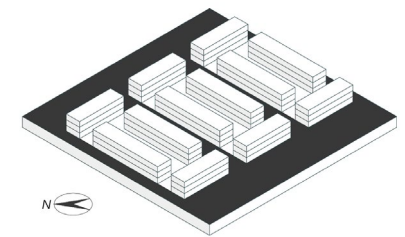
Pocket parks in the courtyards



Creating 'cooling haven' by demolition and compensation within blocks



Introducing front green garden during (re) developments



Courtyard block dwellings or row houses with orientation NE-SW should be encouraged

5 STRATEGIES

What are the strategies from microclimate perspectives? & Who are the stakeholders for the strategies?

Sub-Q V TRANSFERABILITY

Diagram illustrating various vegetation strategies for urban cooling:

- Replacing pavements with grass on public spaces
- Trees in row to protect overheating on western facade
- Planting climbing plants in narrow urban streets canyons
- More vegetations inside the courtyards
- Applying grass planting bricks for parking spaces
- Planting trees as a cluster
- Movable grass beds in public spaces

Vegetations

Diagram illustrating various water strategies for urban cooling:

- Adding canals or large water body during urban (re)developments
- Setting fountains in open spaces
- Setting water misting system in open spaces
- Shallow water gutters on the streets

Water

Temporal Measures

Diagram illustrating various building form strategies for urban cooling:

- Densifying in courtyard block dwellings neighborhoods with apartment buildings
- Pocket parks in the courtyards
- Creating 'cooling haven' by demolition and compensation within blocks
- Introducing front green garden during (re)developments
- Courtyard block dwellings or row houses with orientation NE-SW should be encouraged

Building Forms

Diagram illustrating various occupant behavior strategies for urban cooling:

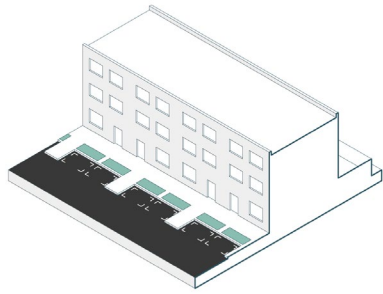
- Smart choices of opening & closing windows
- Preventing interior overheating

Occupants' Behavior

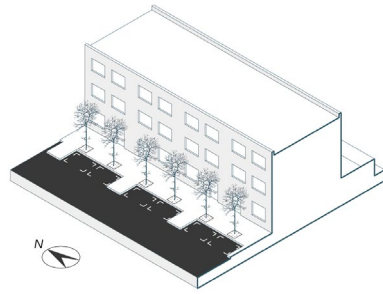
Diagram illustrating various materials and color strategies for urban cooling:

- Local generated air flow
- Encouraging 'light' roofs
- Adding coverings on public streets
- Increasing albedo for facades and pavements in neighborhood streets

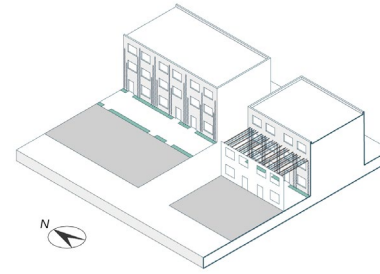
Materials & Color



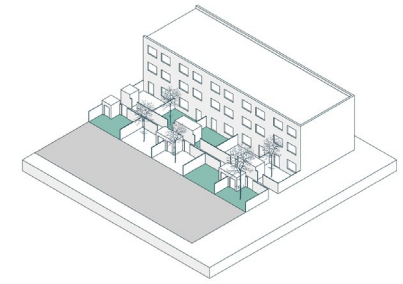
Replacing pavements with grass on public spaces



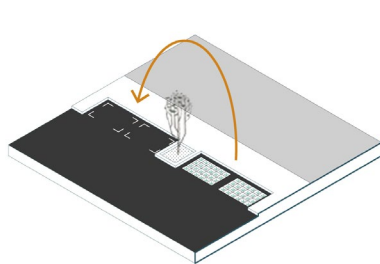
Trees in row to protect overheating on western facade



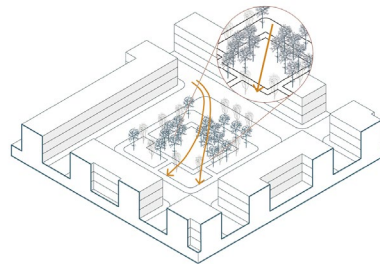
Planting climbing plants in narrow urban streets canyons



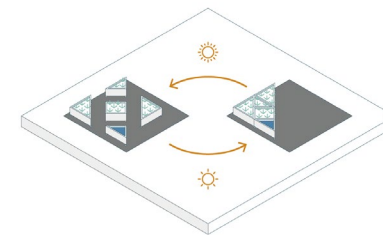
More vegetations inside the courtyards



Replacing pavements with grass on public spaces

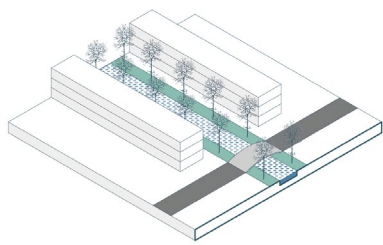


Planting trees as a cluster

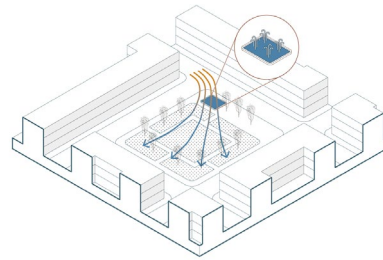


Movable grass beds in public spaces

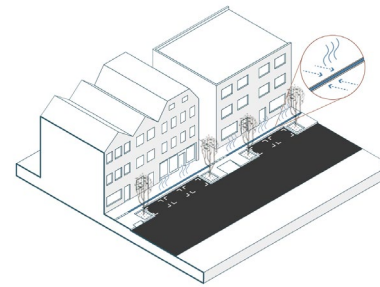




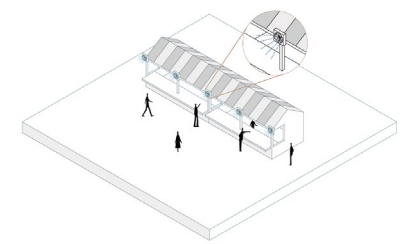
Adding canals or large water body during urban (re)developments



Setting fountains in open spaces

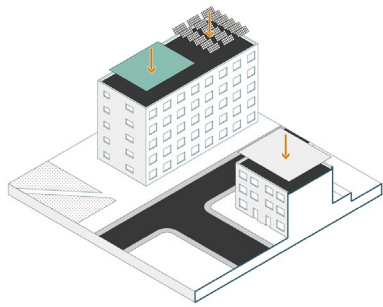


Shallow water gutters on the streets

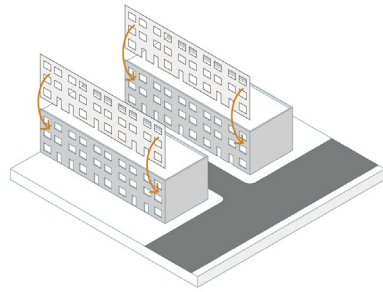


Setting water misting system in open spaces

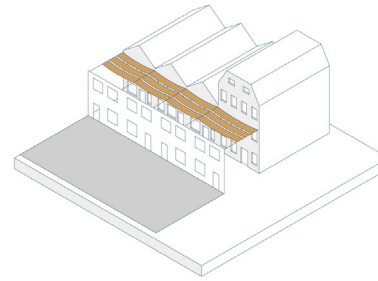




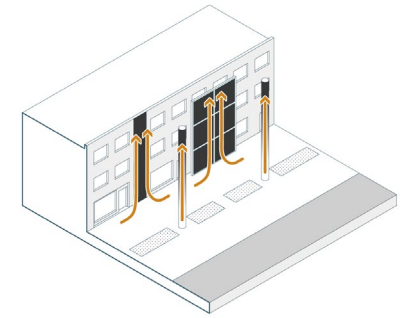
Encouraging 'light' roofs



Increasing albedo for facades in neighborhood streets

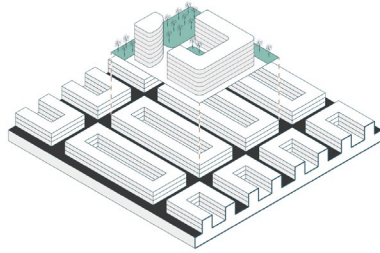


Adding coverings on public streets

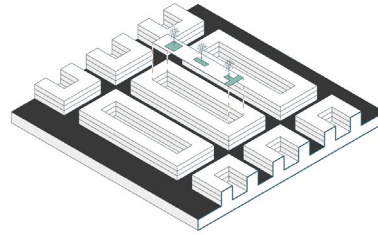


Local generated air flow

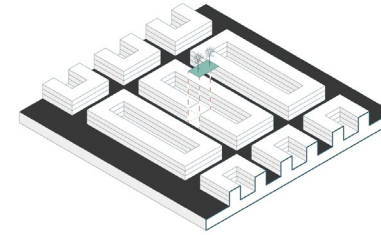




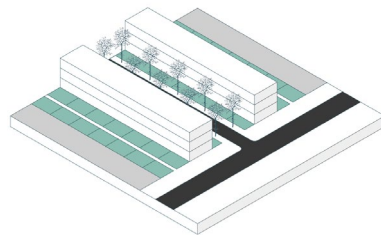
Densifying in courtyard block dwellings neighborhoods with apartment buildings



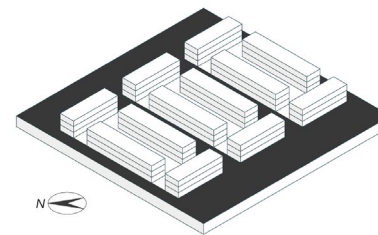
Pocket parks in the courtyards



Creating 'cooling haven' by demolition and compensation within blocks

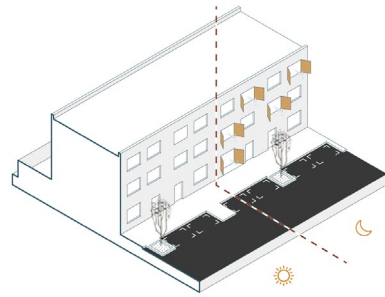


Introducing front green garden during (re)developments

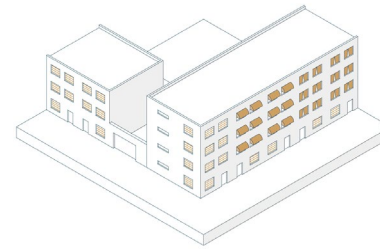


Courtyard block dwellings or row houses with orientation NE-SW should be encouraged





Smart choices of opening & closing windows



Preventing interior overheating



6 DESIGN

How should the strategies from microclimate perspectives be applied into practice? & Could the strategies improve outdoor thermal comfort?

Sub-Q III & IV EFFECTIVENESS & EQUITY

Selected Building Clusters



Satellite image of selected building clusters.



Location of selected building clusters.

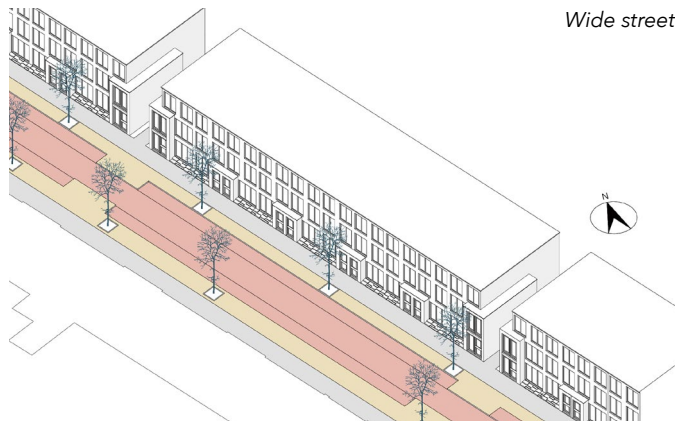
Sections & Plan of Neighborhood Streets



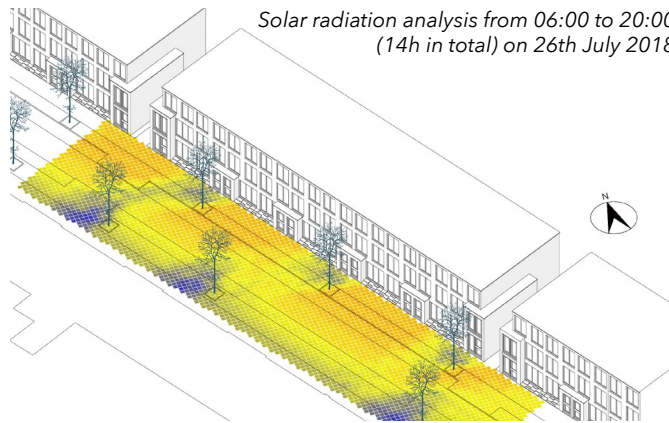
Street view of wide street (top) and narrow street (bottom).

Conceptual plan and section of wide street (left) and narrow street (right).

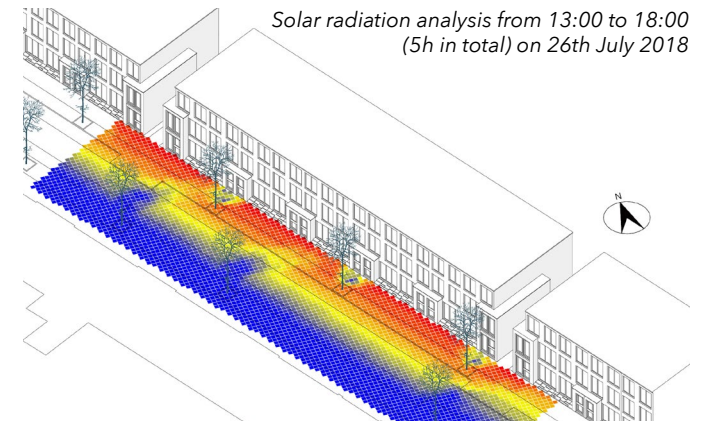
Analysis of Functions & Solar Radiation on Wide Street and Narrow Street



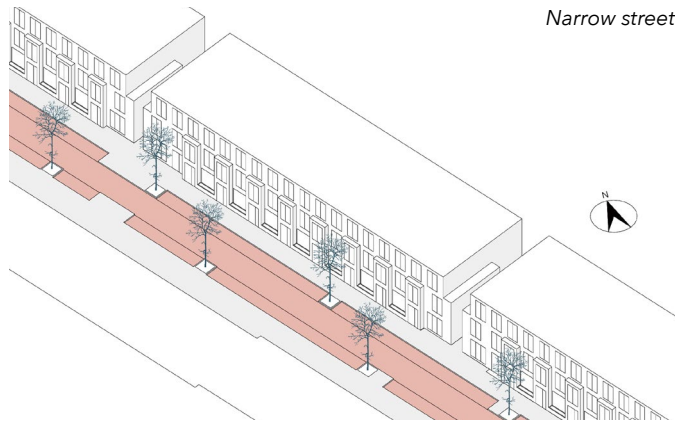
Wide street



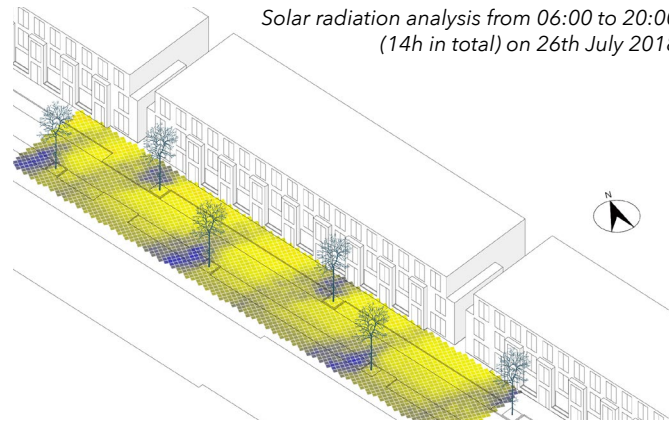
Solar radiation analysis from 06:00 to 20:00
(14h in total) on 26th July 2018



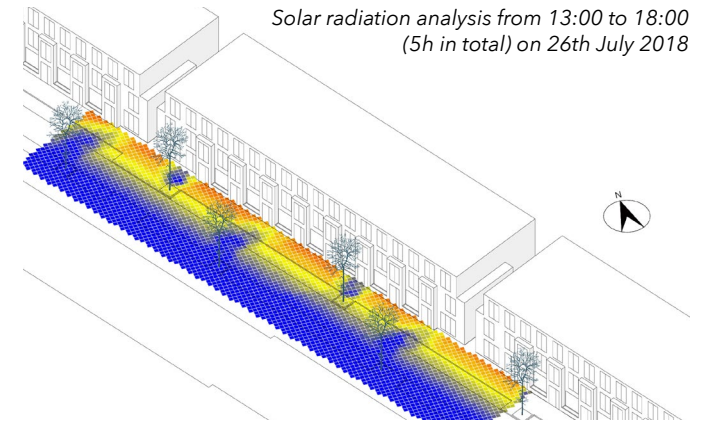
Solar radiation analysis from 13:00 to 18:00
(5h in total) on 26th July 2018



Narrow street

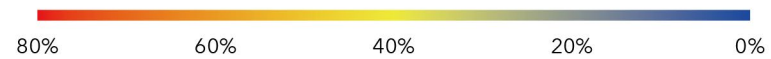


Solar radiation analysis from 06:00 to 20:00
(14h in total) on 26th July 2018

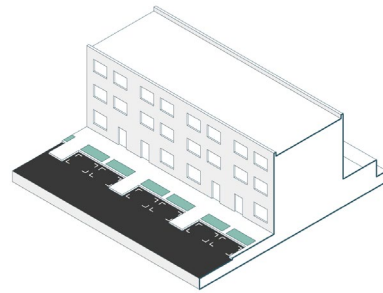


Solar radiation analysis from 13:00 to 18:00
(5h in total) on 26th July 2018

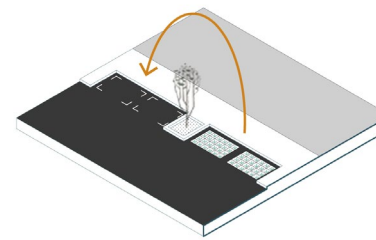
- Gray bricks for sidewalks
- Brown bricks for sidewalks
- Red bricks for roads & parking



Analysis of Functions & Solar Radiation on Wide Street and Narrow Street

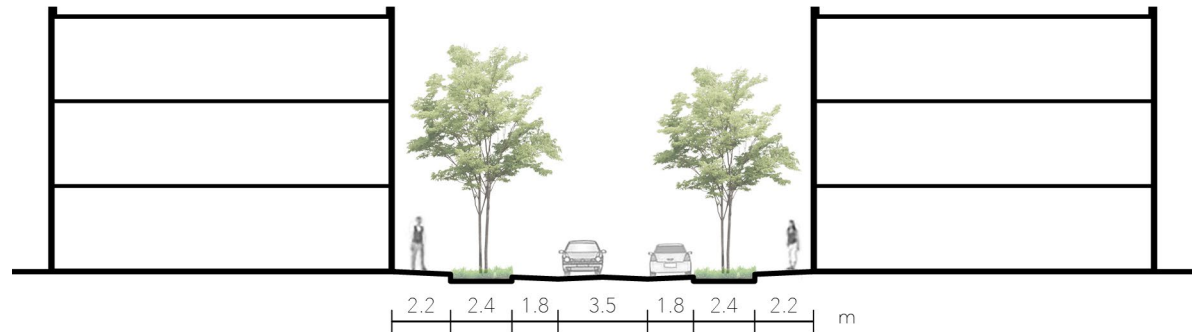
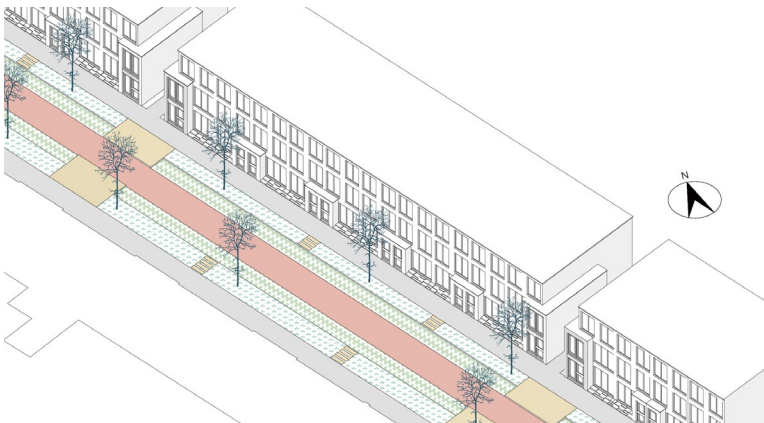
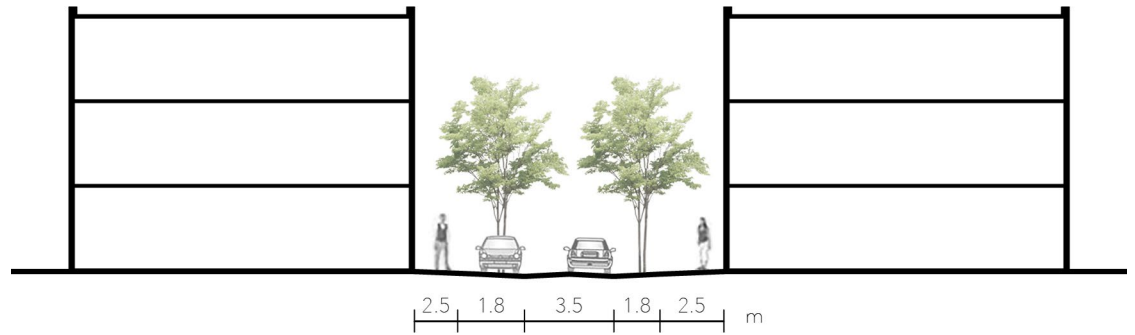
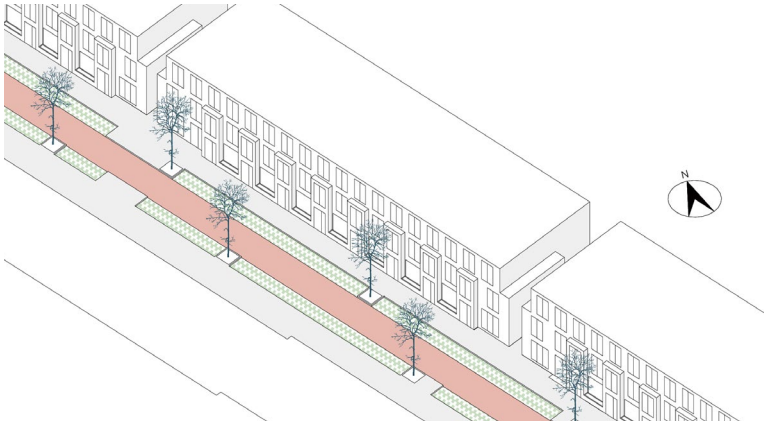



Replacing pavements with grass on public spaces



Applying grass planting bricks for parking spaces

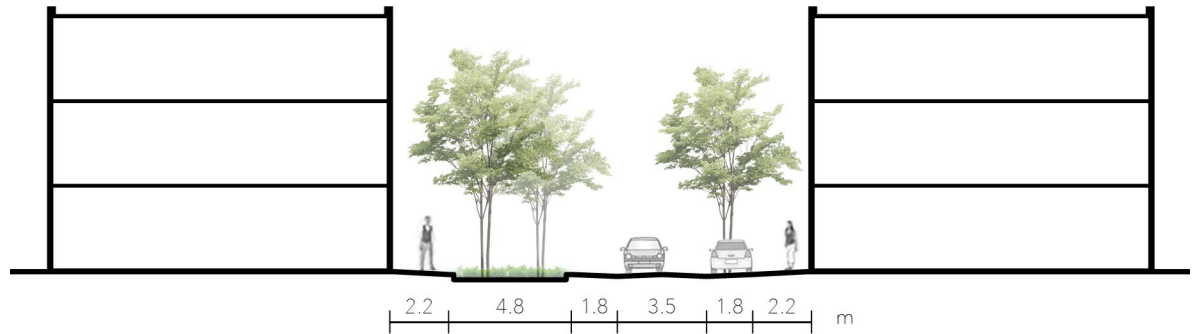
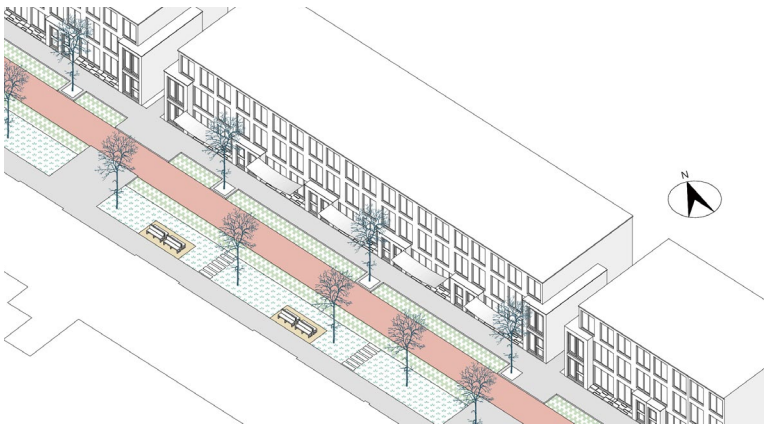
Interventions of Pavements on the Neighborhood Streets





 Grass planting bricks

 Grass

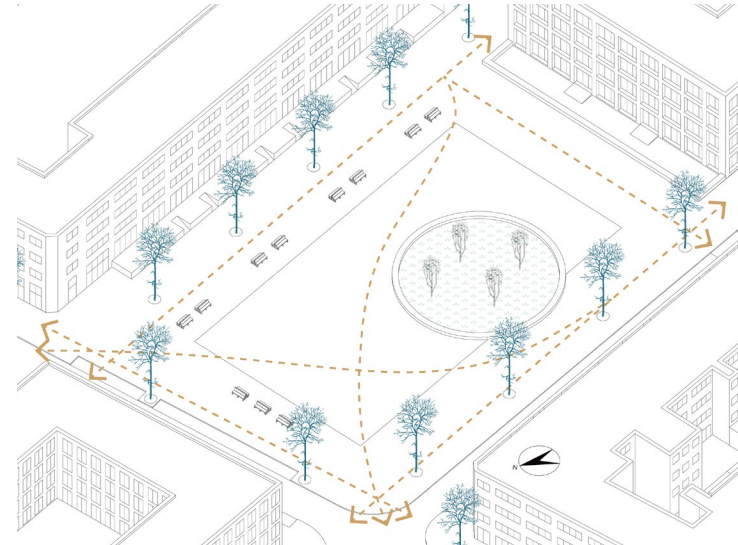
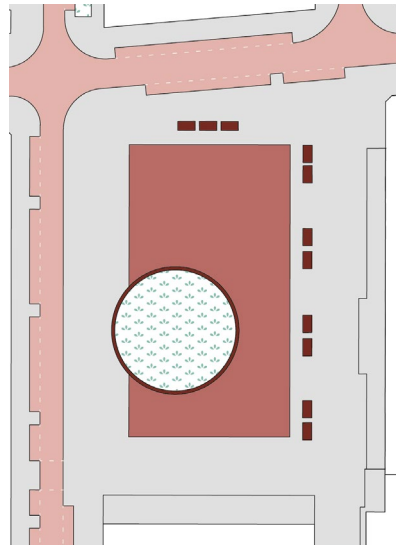
An Introduction of New Street Profile on 'Wide Street'



 Grass planting bricks

 Grass

Functions & Pavements in Stellenboschplein

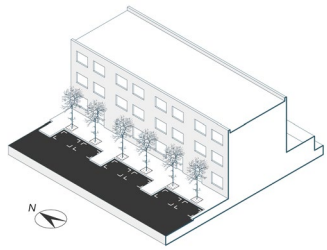


- Red bricks for roads & parking
- Red bricks for square
- Gray bricks for sidewalks
- Grass
- Benches and seats

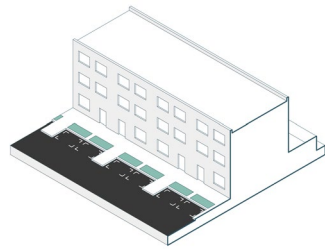


← - - - - -> Prediction of route of pedestrians

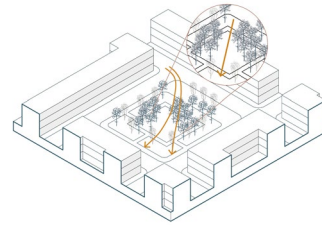
Selection & Application of Strategies in Stellenboschplein



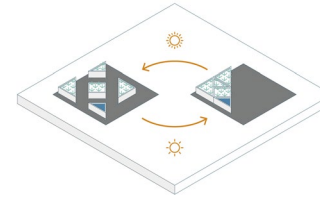
Trees in row to protect overheating on western facade



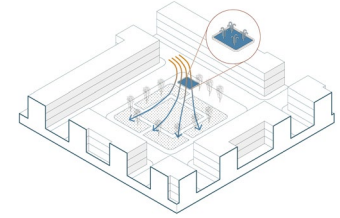
Replacing pavements with grass on public spaces



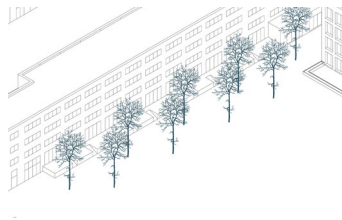
Planting trees as a cluster



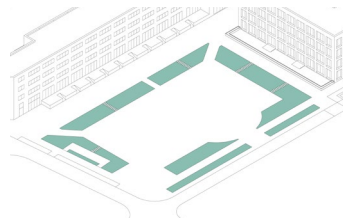
Movable grass beds in public spaces



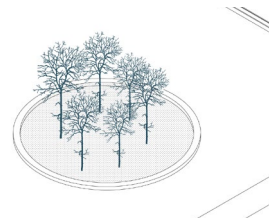
Setting fountains in open spaces



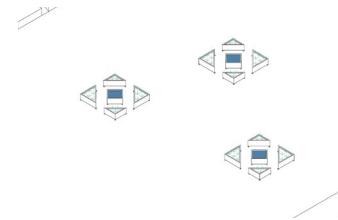
New trees are planted in rows to protect facades and provide shading on pedestrian level.



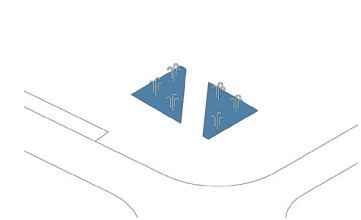
Extra pavements for sidewalks are replaced by grass.



Trees are planted as a cluster in the round terrace with seats to provide dynamic shading on the seats.

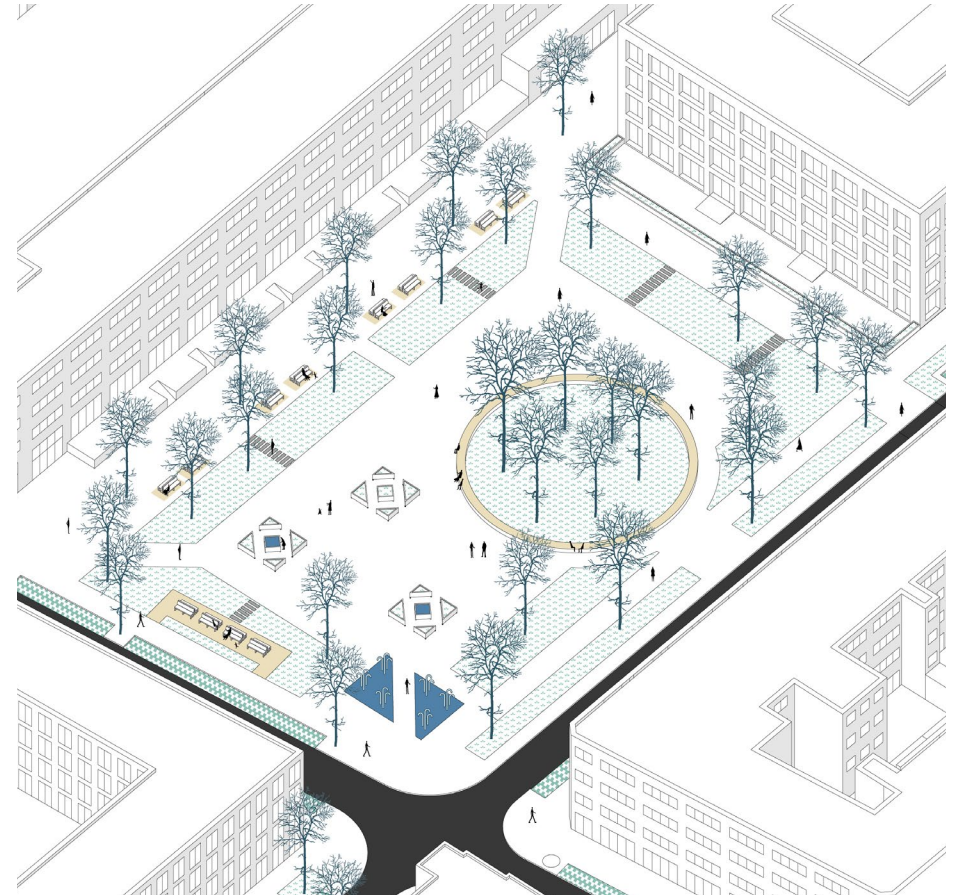
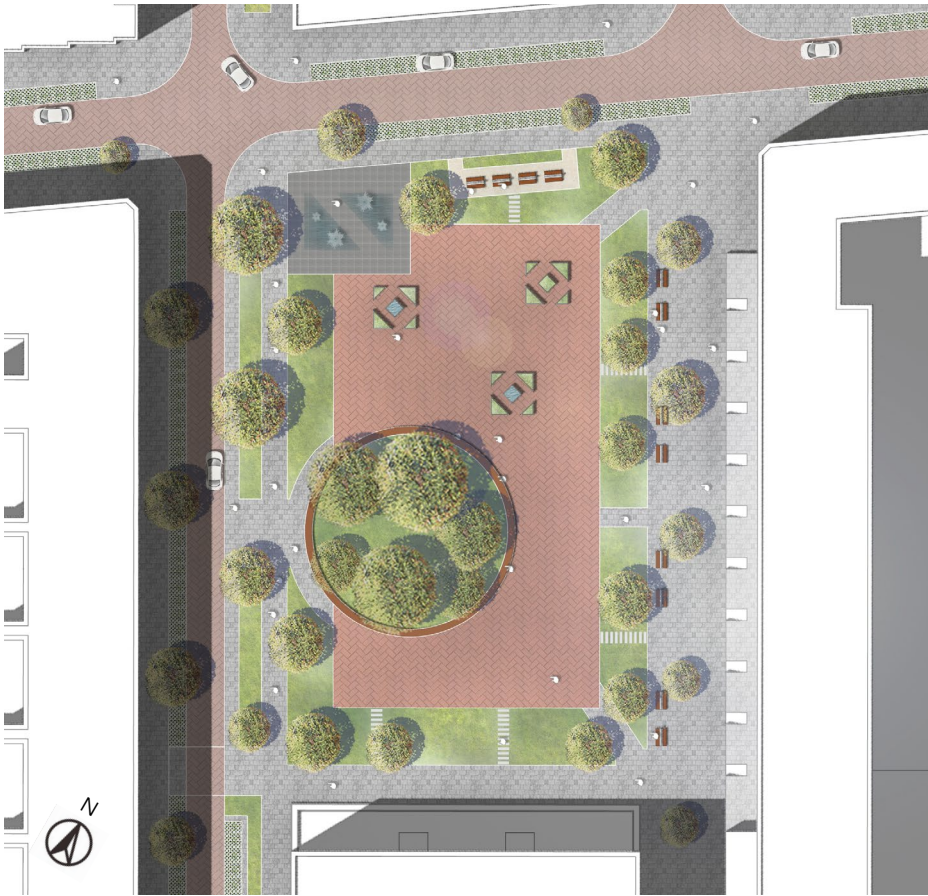


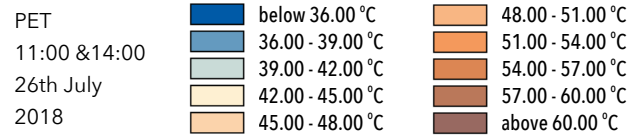
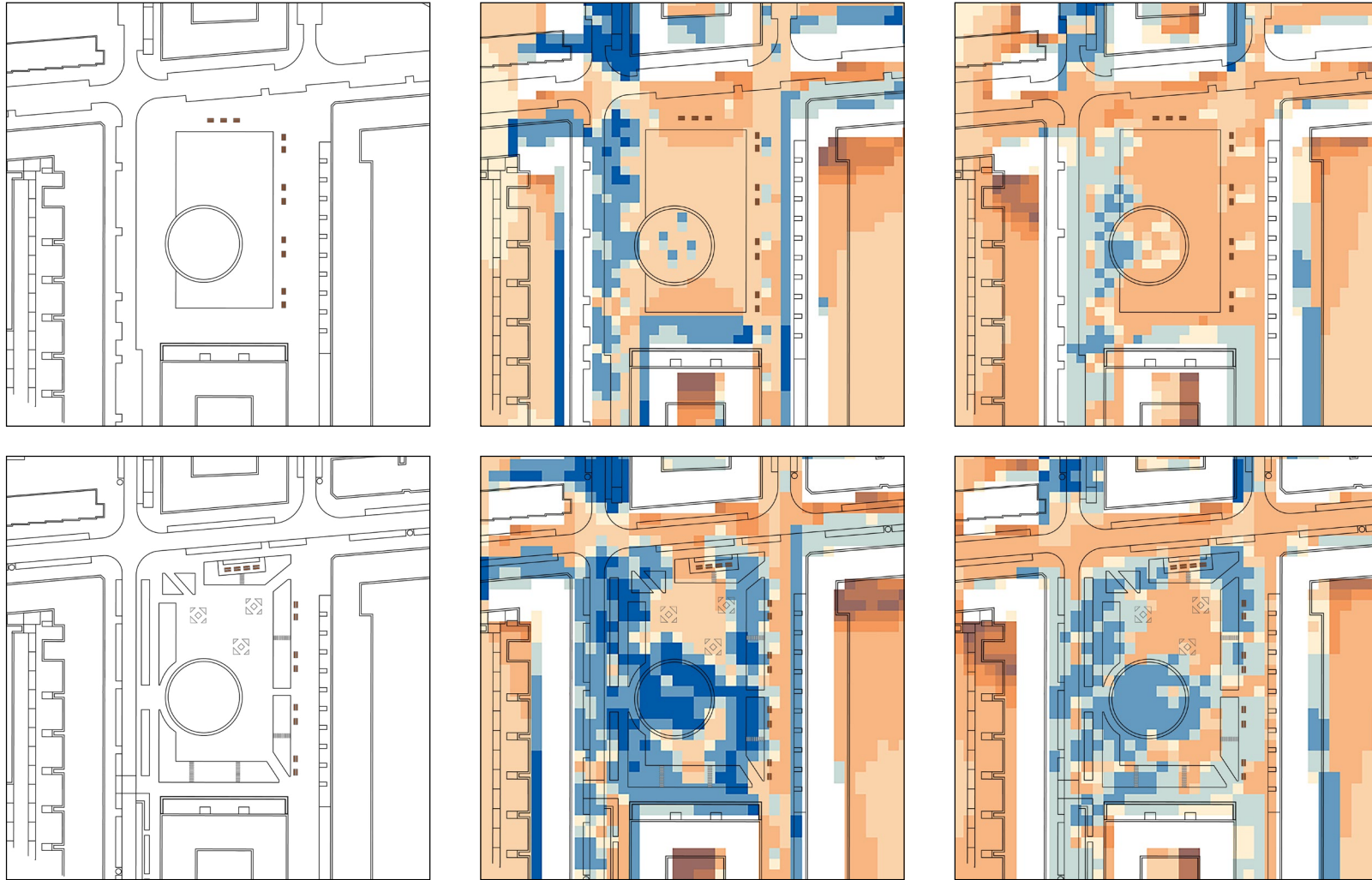
Movable grass beds combined with water elements offer more interaction among the citizens.



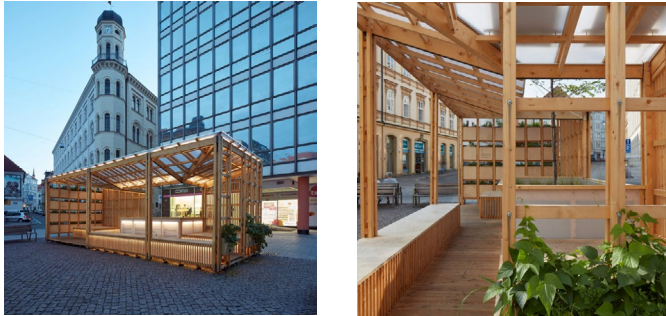
A seasonal fountain is set at the crossing to cool down the sidewalks and open spaces.

Plan & Axonometric Drawing of Redevelopment in Stellenboschplein



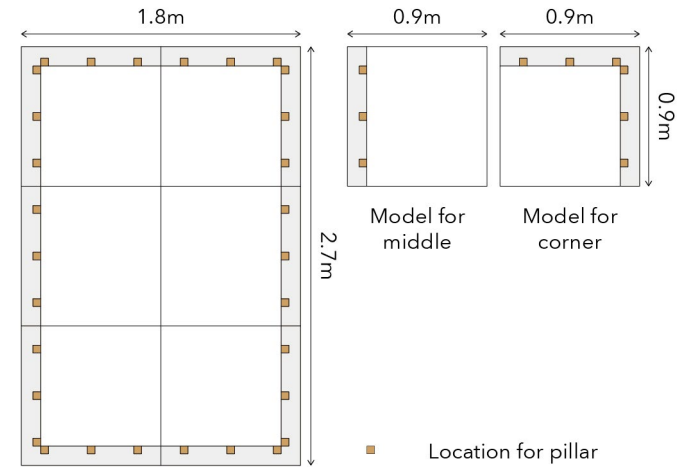


City Cell Prototype



Design by NEXT Institute; Source: <https://www.gooood.cn/city-cell-prototype-by-next-institute.htm?lang=cn>

Basic Models of 'Cooling Sheds'

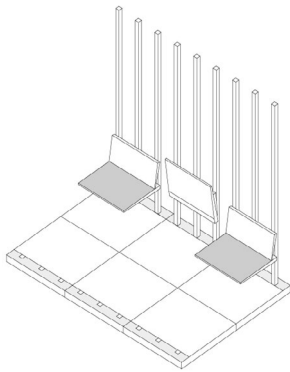


Inside

Resting

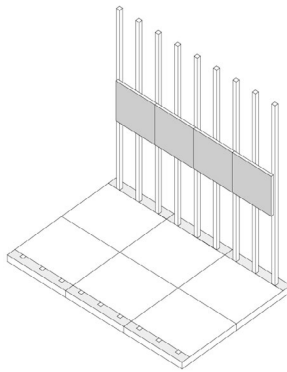
Improving Microclimate

A



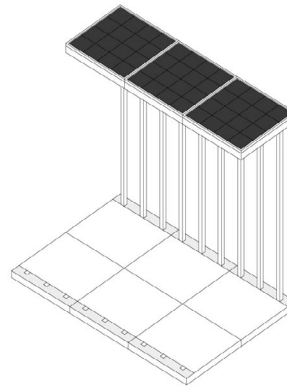
Flexible seats inside

C



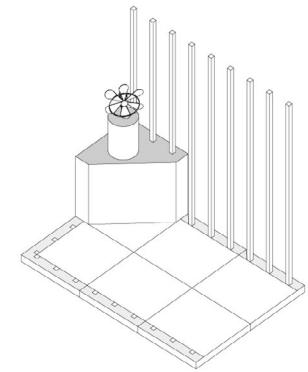
Backrest

E



Solar panels

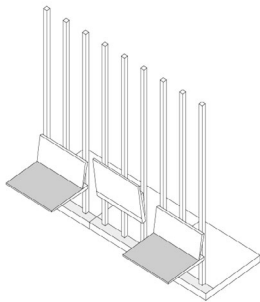
G



Water mist fan

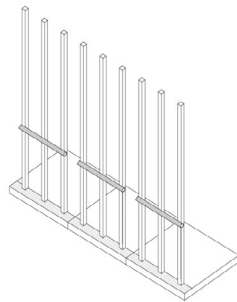
Outside

B



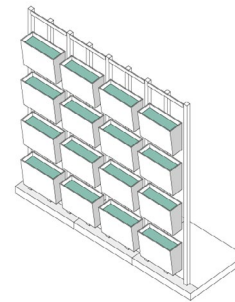
Flexible seats outside

D



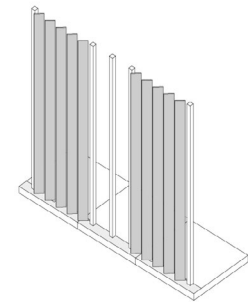
Handle

F



Green wall

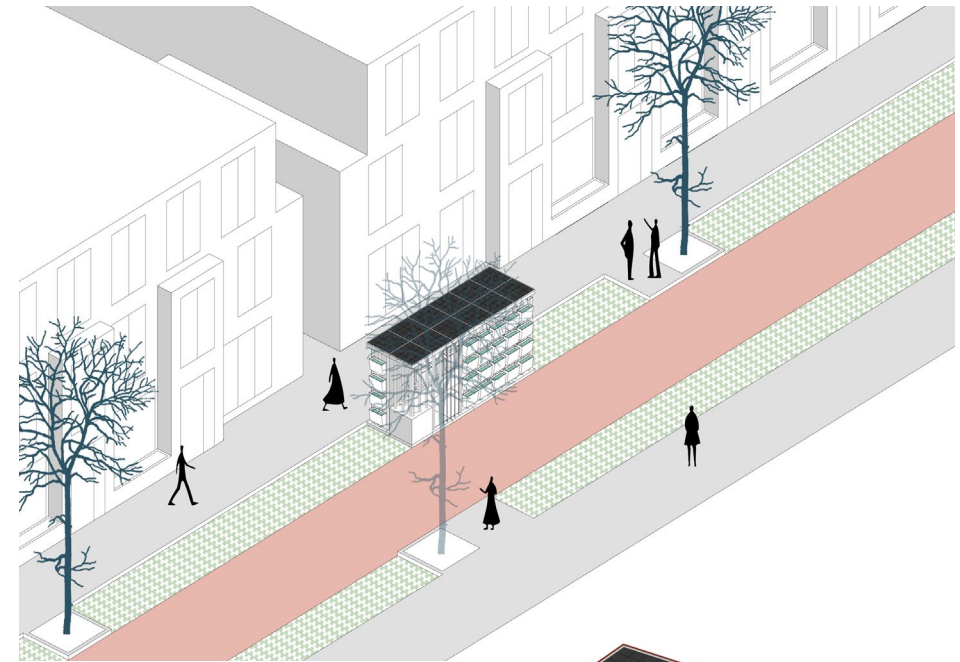
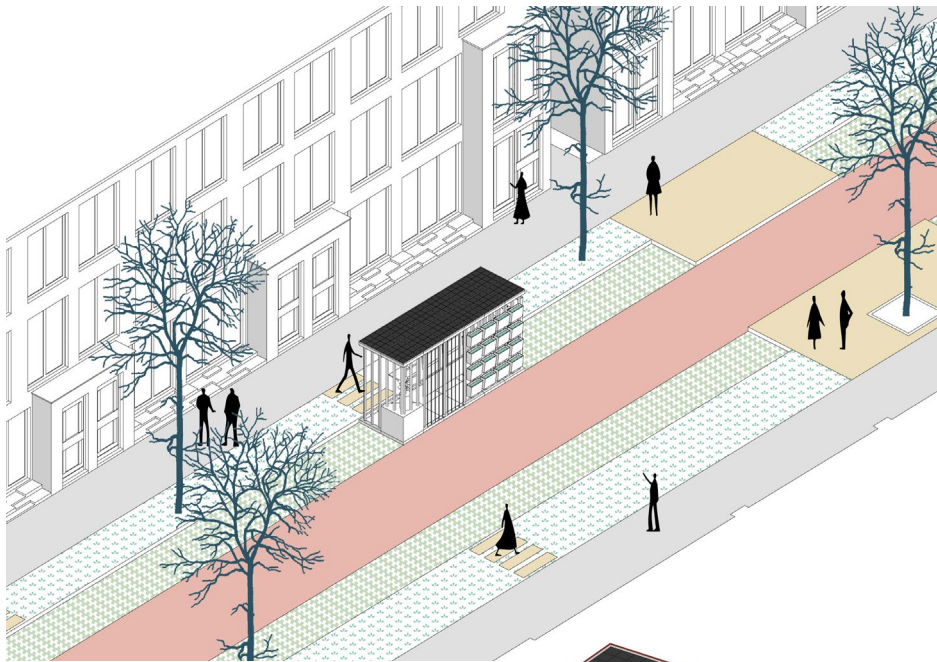
H



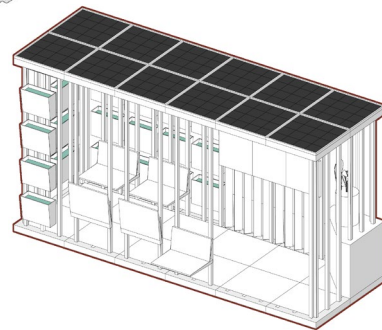
Solar fence

Relatively open 'Cooling sheds' on the 'wide street'

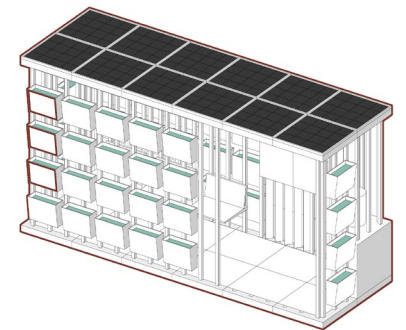
Relatively closed 'Cooling shed's on the 'narrow street'

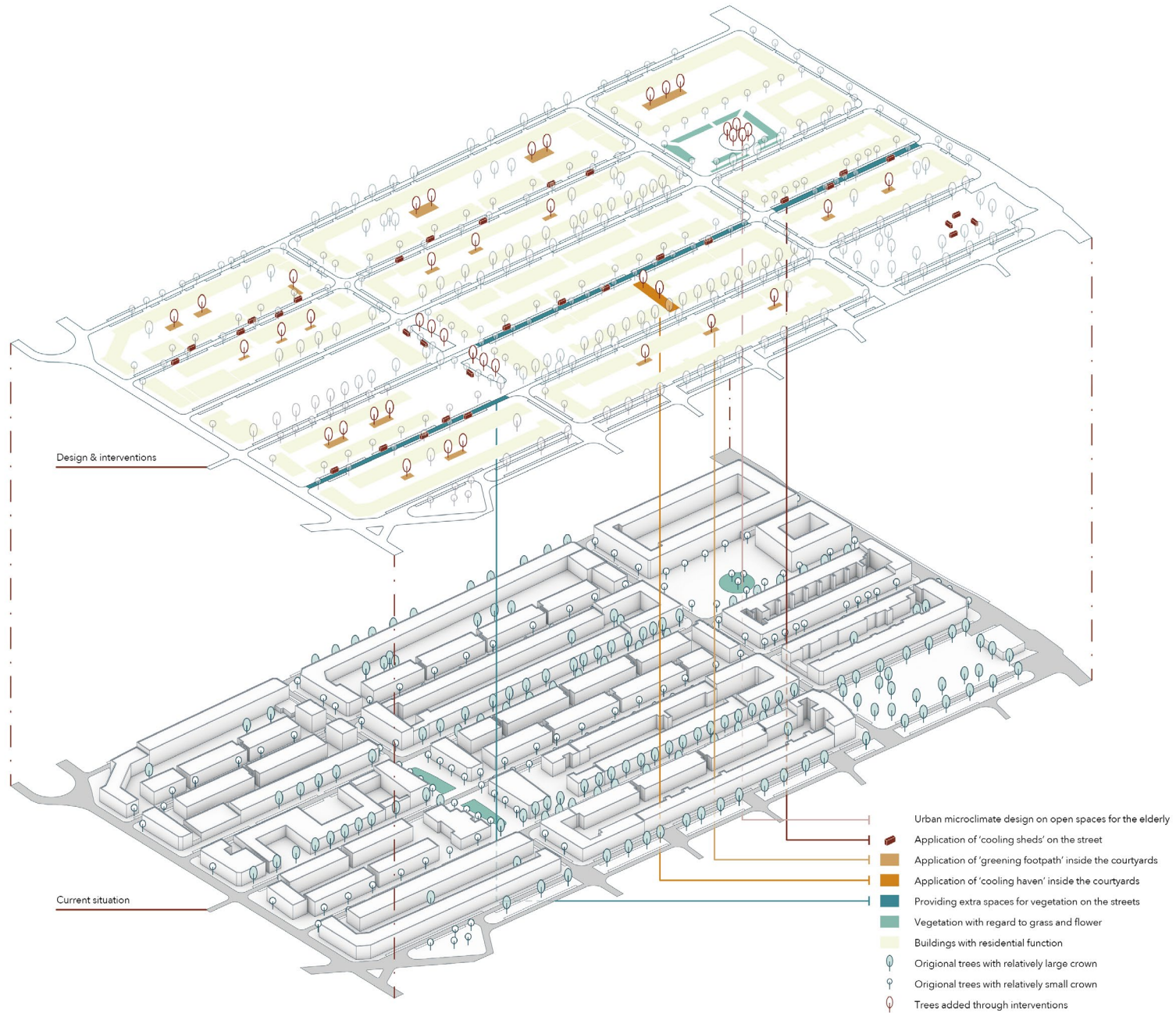


The 'Cooling sheds' with more openness could be placed on the parking space of the 'wide street' next to the stripe of grasslands to offer more interaction between the people inside and outside of the 'Cooling sheds'.



The 'Cooling sheds' with less openness could be placed on the parking space of the 'narrow street' and shapes a relatively cooler atmosphere inside the 'Cooling sheds'. The vegetations on the 'Cooling sheds' could also help to add the element of plants on the street.



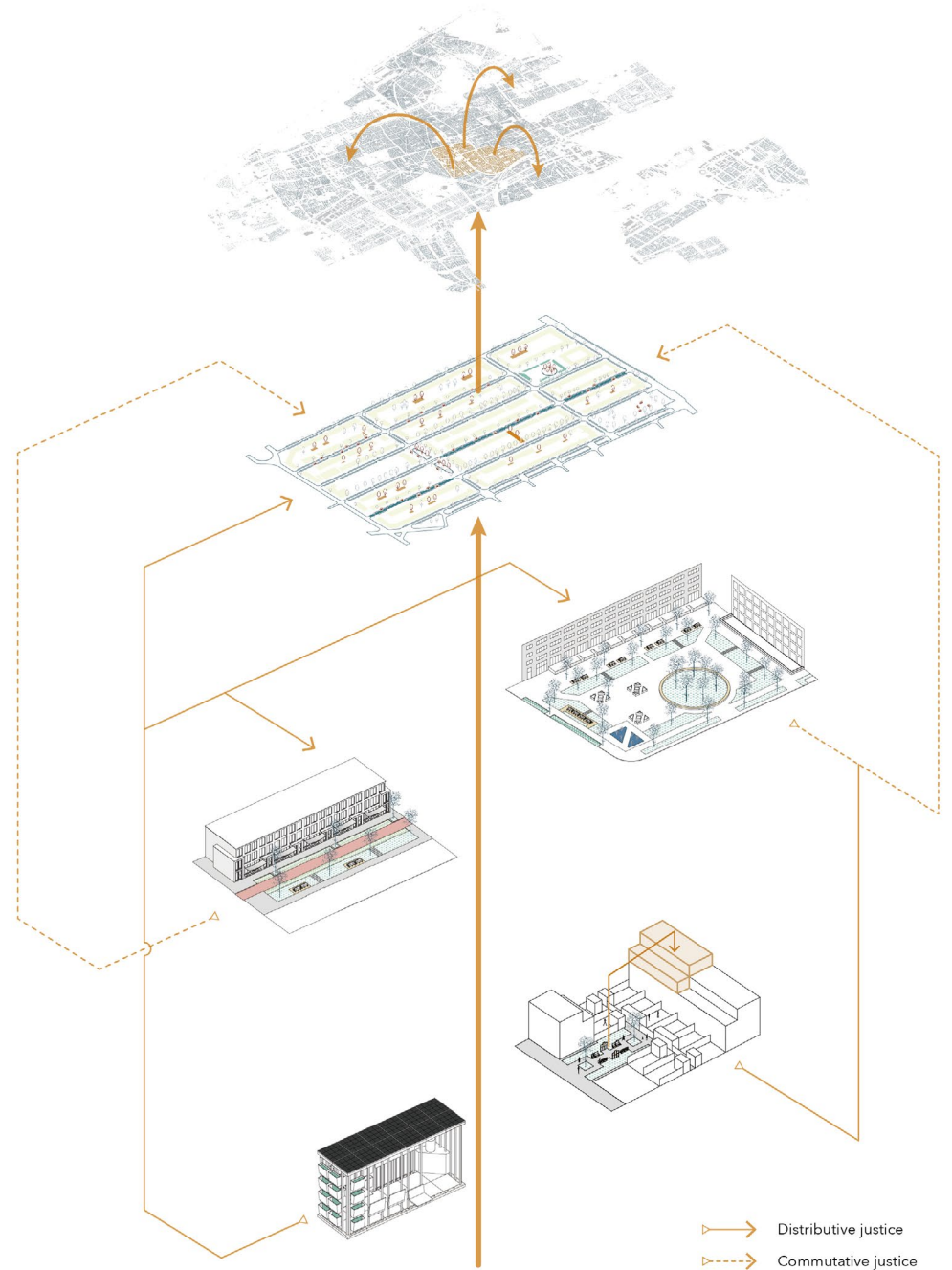
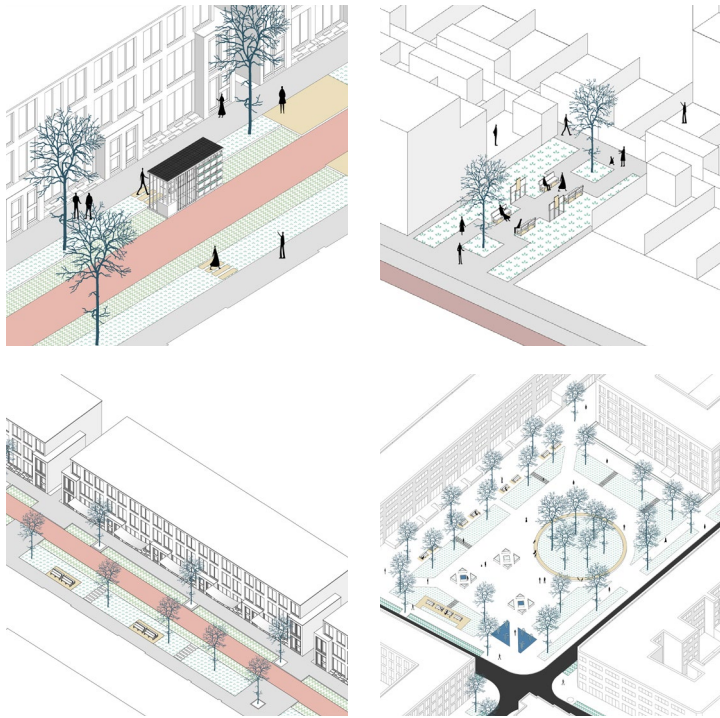


7 CONCLUSION

How could urban design reduce heat stress for the elderly in The Netherlands?

RESEARCH QUESTION

7 CONCLUSION



THANK YOU