KU LEUVEN

Leuven.cool: A citizen science initiative on urban temperatures and heat stress

Leuven 2030 Urban Lab

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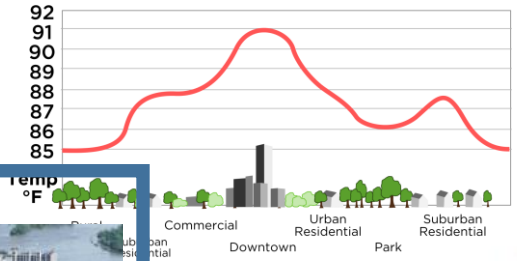
URBANIZATION, CLIMATE & HUMAN HEALTH

URBAN HEAT ISLAND PROFILE



URBAN FLOODING

URBAN DROUGHT

Satellite image of the Chennai reservoir before the drought (left) and during the drought (right).
Source: Maxar Technologies

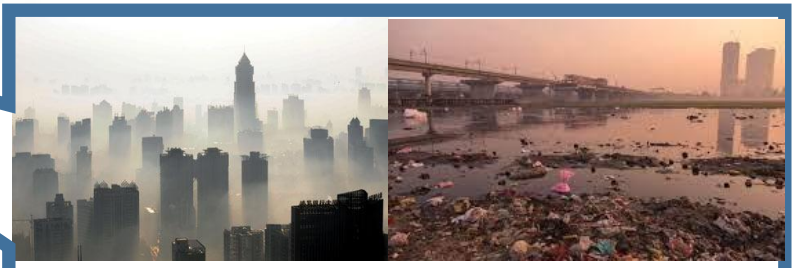
NOISE POLLUTION

SMELL POLLUTION

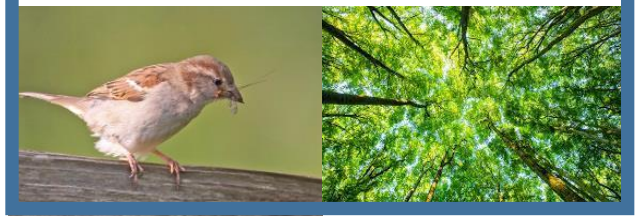
LIGHT POLLUTION

View of London light pollution at night from space © Vladi333/Shutterstock

AIR, WATER & SOIL POLLUTION



BIODIVERSITY LOSS



OVERCROWDING

57% of the world's population live in urban areas

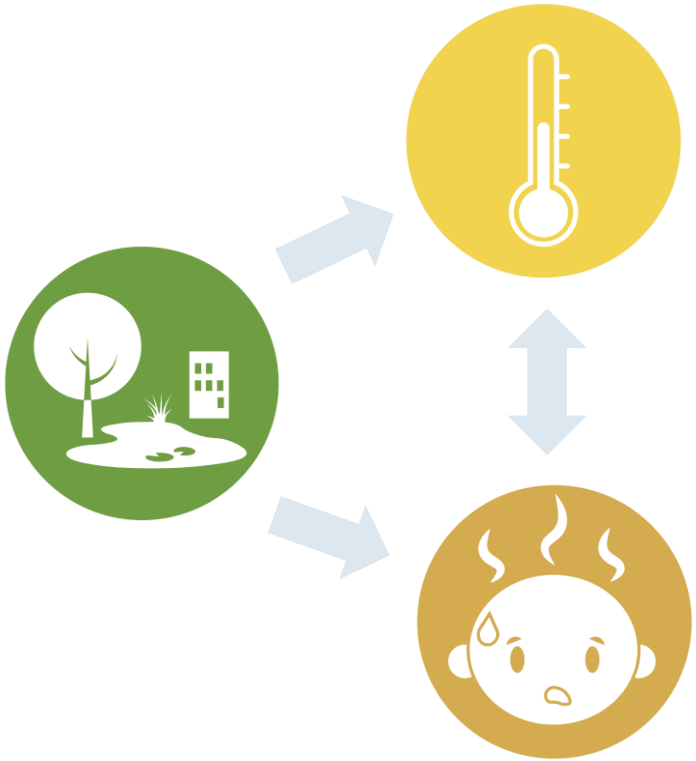
UNCTAD Handbook of Statistics 2022

Goal

Understanding and reinforcing (the role of) urban green and blue in urban climate mitigation and adaptation

⇨ Quantifying the impact of landcover

- on the local urban climate and
- on citizens health and well-being



Objective 1

1. Meteorological data acquisition

In situ sensor network ⇒ Air Temperatures

Quality control analysis of crowdsources weather stations

Objective 2

2. Quantifying UHI

Objective 3

3. Quantifying thermal discomfort

Objective E

Urban green and blue infrastructure

Objective 4

4. Quantifying spatio-temporal interactions between urban green/blue, temperature and thermal comfort

Meteorological data acquisition

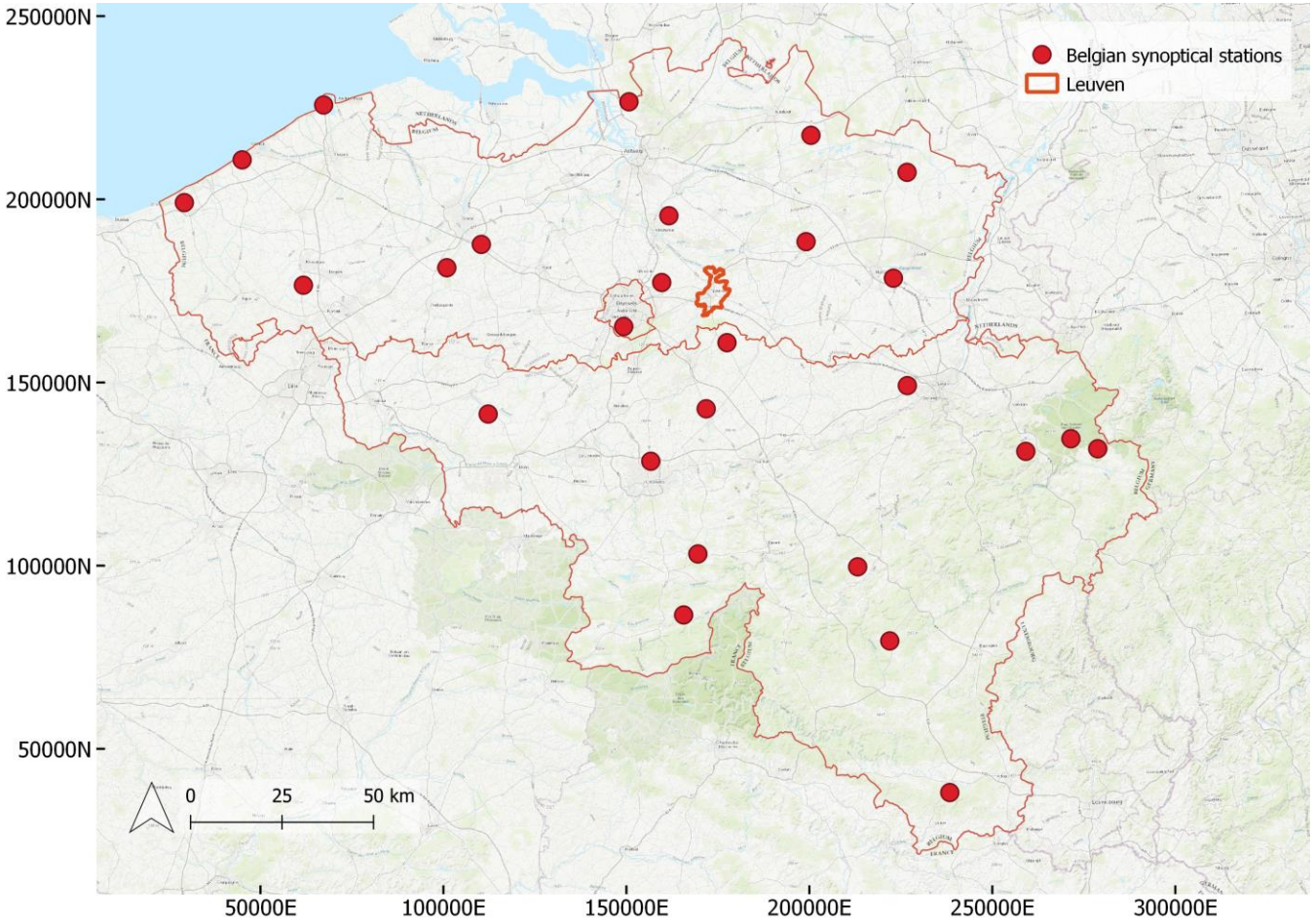
Problem statement

Official weather station networks = sparse

⇨ High installation + maintenance cost

⇨ Strict siting instructions

⇨ Not suitable for city specific or intra-urban weather phenomena



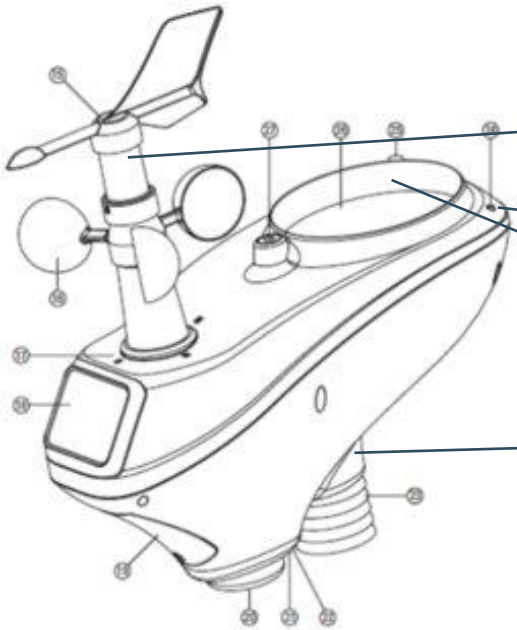
Meteorological data acquisition

Leuven.cool project

Collaboration between KU Leuven - RMI - the city of Leuven

⇨ Measure the micro-climate in Leuven and investigate the mitigating effects of green and blue infrastructures, both in the city center and in private gardens of citizens

Renkforce WH2600



Wind speed
Wind direction

Radiation

Rainfall

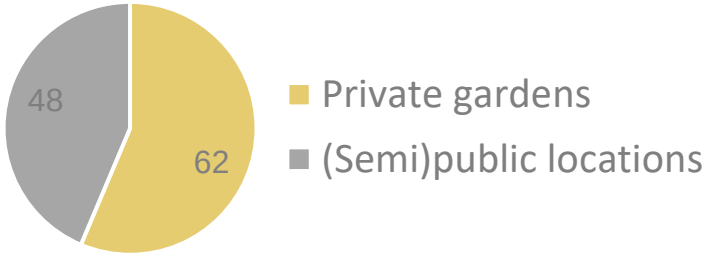
Temperature
Relative humidity

Meteorological data acquisition

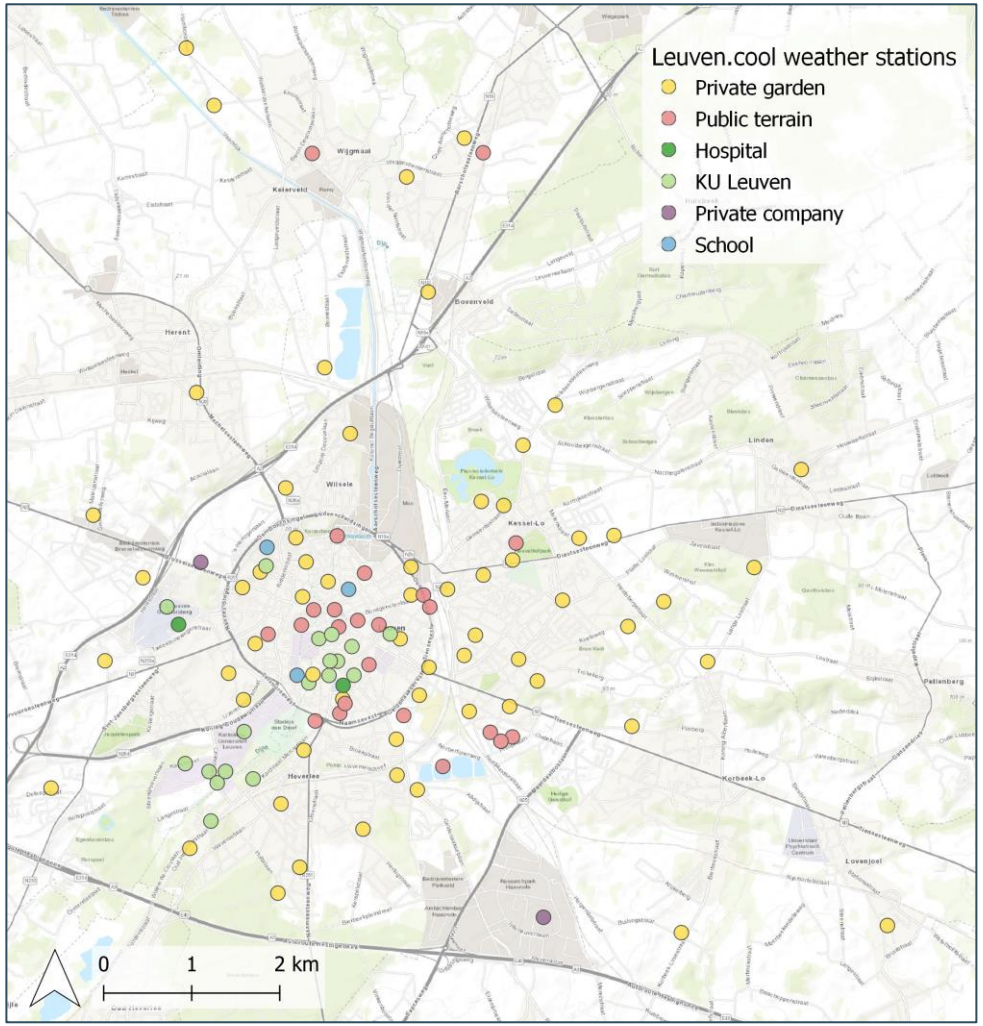
The complete Leuven.cool network consists of 114 weather stations

- 110 base stations
- 4 reference stations

The main Leuven.cool network counts 110 weather stations located in Leuven and its surroundings



Sampling design is based on the concept of local climate zones



Meteorological data acquisition

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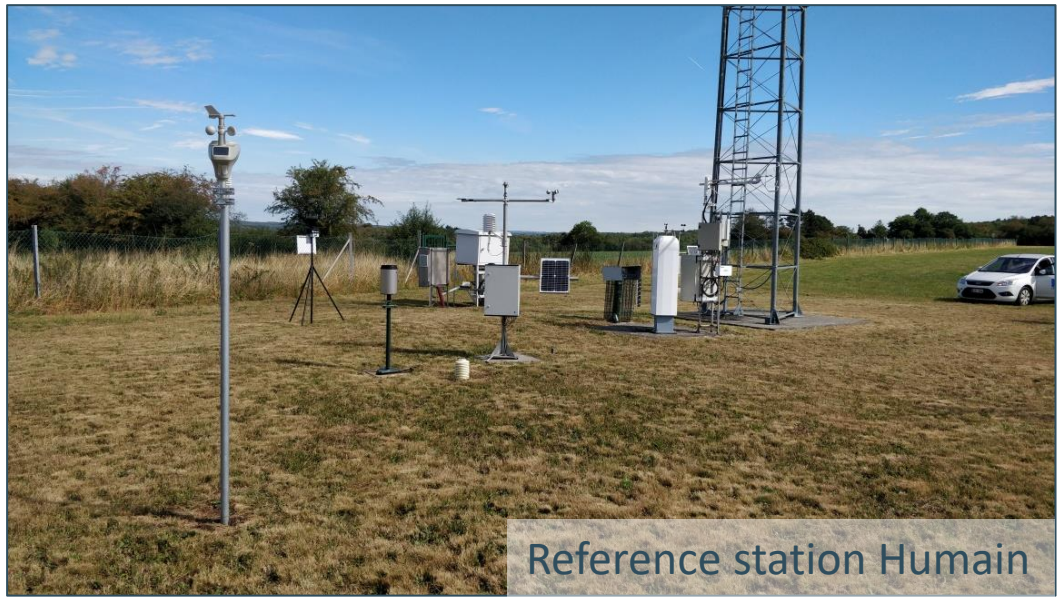
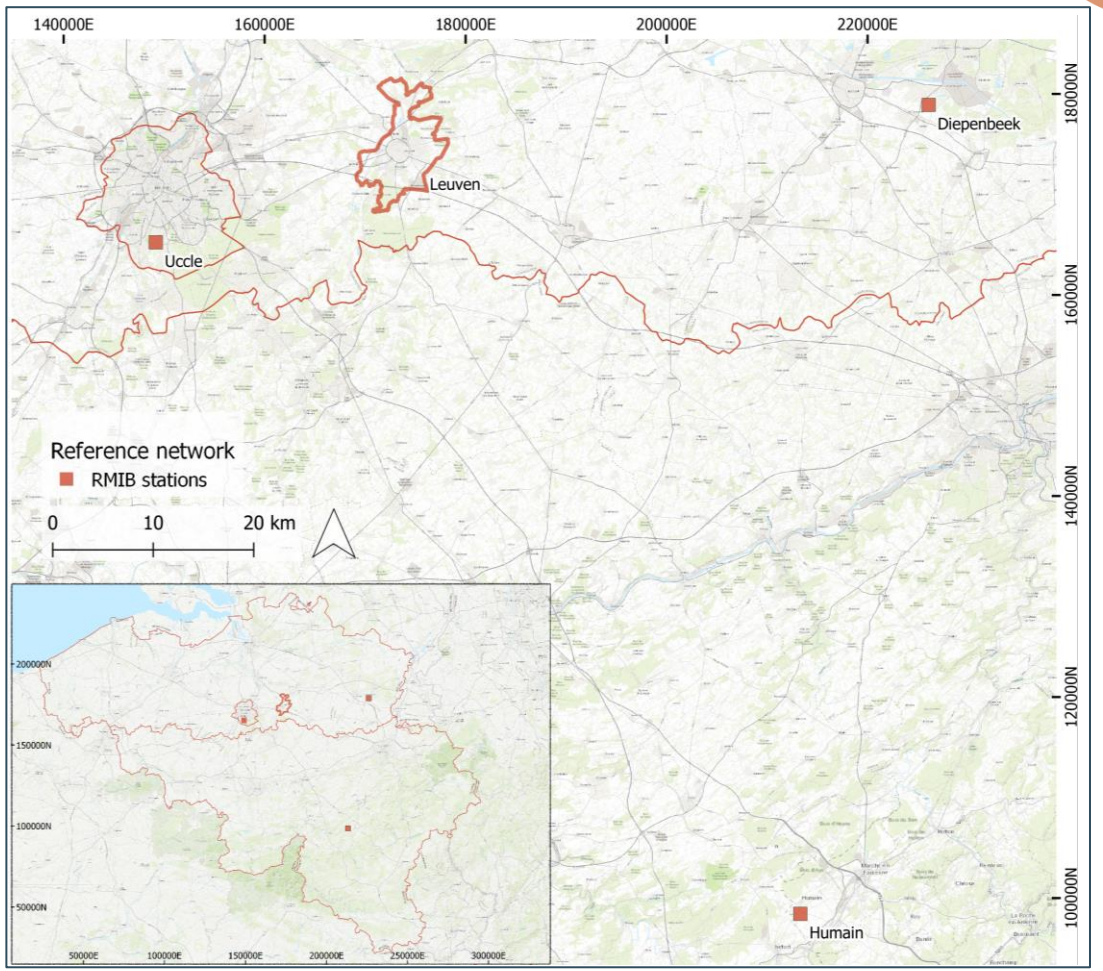


Reference station Humain



Data quality control analysis

Replication Data for: Quality control and correction method for air temperature data from a citizen science weather station network in Leuven, Belgium

Version 2.0

- Dataset + data paper have been published
- Dataset is open access (CC-BY-NC-4.0), contains raw & corrected T data and R-scripts

Beele, E., Reyniers, M., Aerts, R., and Somers, B.: Quality control and correction method for air temperature data from a citizen science weather station network in Leuven, Belgium , Earth Syst. Sci. Data, 14, 4681–4717, https://doi.org/10.5194/essd-14-4681-2022, 2022.

Beele, E., Reyniers, M., Aerts, R., and Somers, B.: Replication Data for: Quality control and correction method for air temperature data from a citizen science weather station network in Leuven, Belgium, KU Leuven RDR [data set], https://doi.org/10.48804/SSRN3F, 2022.

Objective 1

1. Meteorological data acquisition

Objective 2

2. Quantifying UHI

Spatio-temporal UHI maps

Objective 3

3. Quantifying thermal discomfort

Objective E

Urban green and blue infrastructure

Local climate zone map ⇒ inter and intra LCZ variability

Landscape metrics ⇒ the composition and configuration of urban green/blue

Objective 4

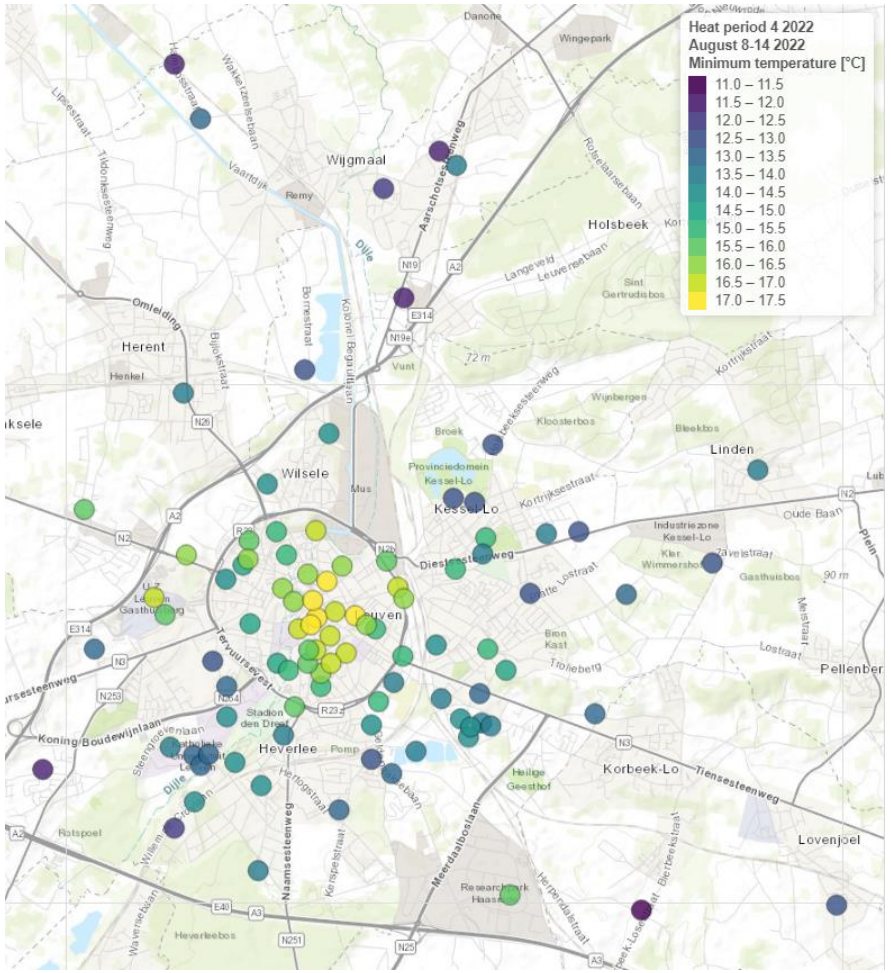
4. Quantifying spatio-temporal interactions between urban green/blue, temperature and thermal comfort

Urban heat island

UHI indicators

- Minimum T
- Cooling degree days

⇨ Drivers of UHI?



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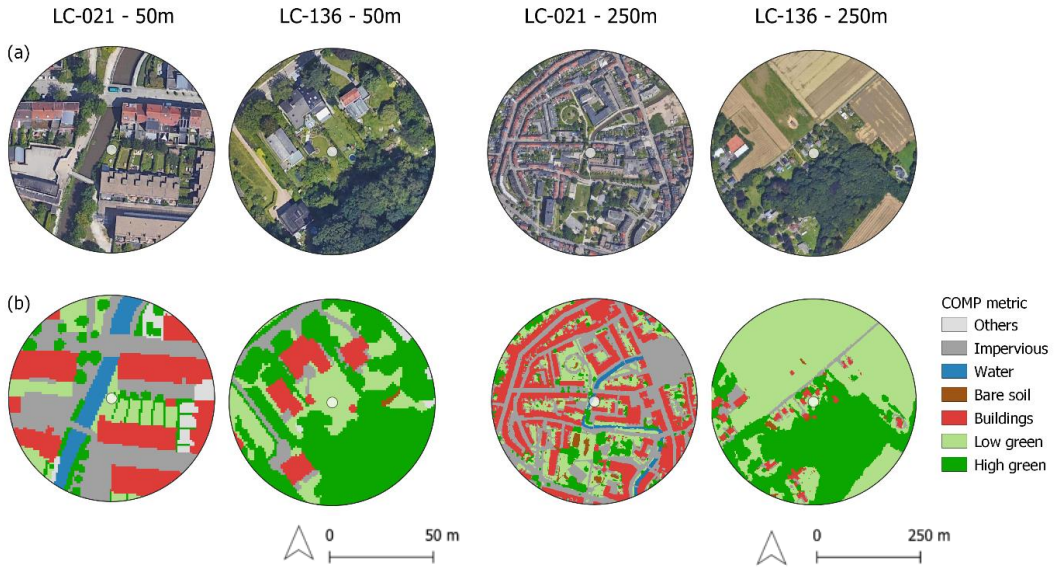
Urban green space

Urban green space
- Relative cover
- Aggregation
- Shape complexity

Characterize land cover around weather stations

Simplification of land cover:
- High green & Low green
- Buildings
- Impervious



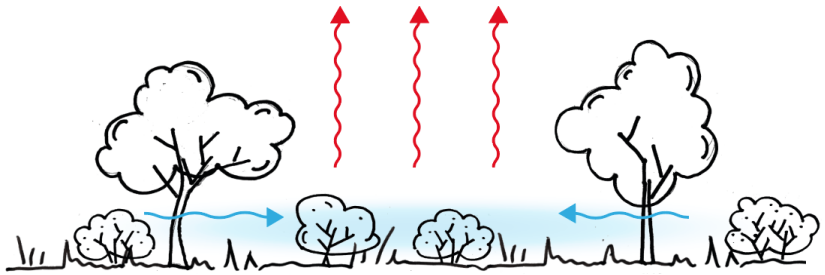
Impact land cover

Main results: aggregation & shape

Cooling at night	
↑ aggregation high green	-
↑ aggregation low green	0.20-1.60°C ↓
↑ complexity high green	0.45°C ↓
↑ complexity low green	0.20-1.50°C ↓

Cooling during daytime	
↑ aggregation high green	0.40°C ↓
↑ aggregation low green	-
↑ complexity high green	-
↑ complexity low green	-

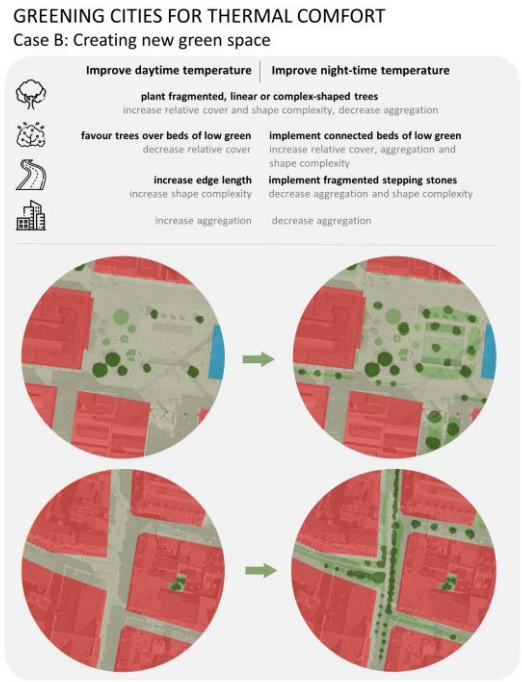
⇨ Urban savanna:
Interconnected low green + distinctive stand-alone high green (= cooling due to ventilation)

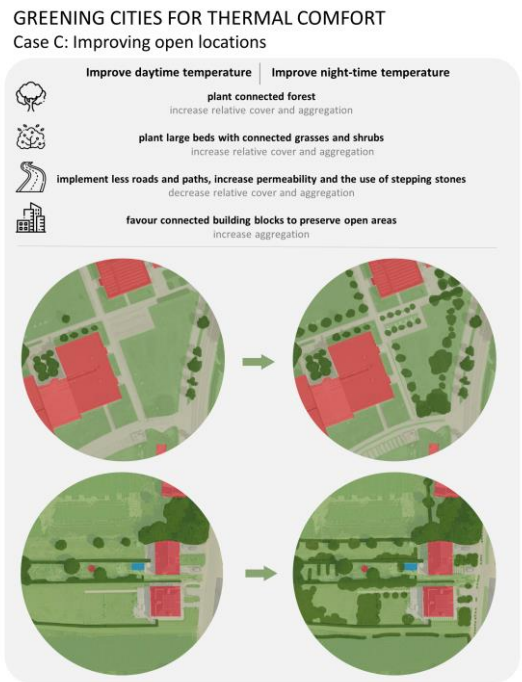


⇨ Urban forest:
Interconnected high green (= cooling due to transpiration and shadow)

Impact land cover

Planning strategies:





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3 indicators of stress

Objective E

Urban green and blue infrastructure

Local climate zone map ⇒ inter and intra LCZ variability

Landscape metrics ⇒ the composition and configuration of urban green/blue

Objective 4

4. Quantifying spatio-temporal interactions between urban green/blue, temperature and thermal comfort

Thermal comfort questionnaire

Questionnaire

1. Socio-economic background
2. Heat stress questionnaire

Heat period

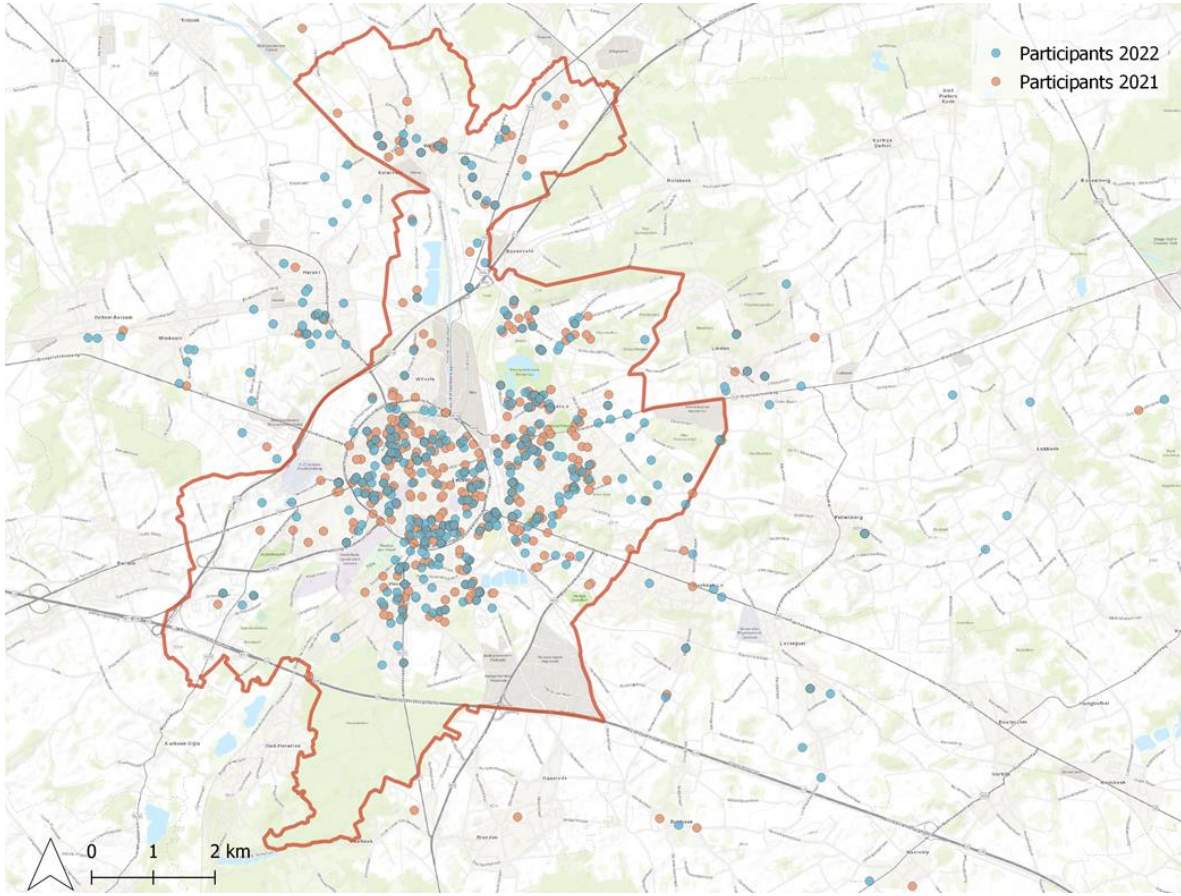
Reference period

Risk & vulnerability survey

- Physical sensitivity:
  age, health/fitness, diseases, medical drugs
- Socio-economic sensitivity:
  awareness/resources (education, income, …)
- Environmental exposure:
  personal living space

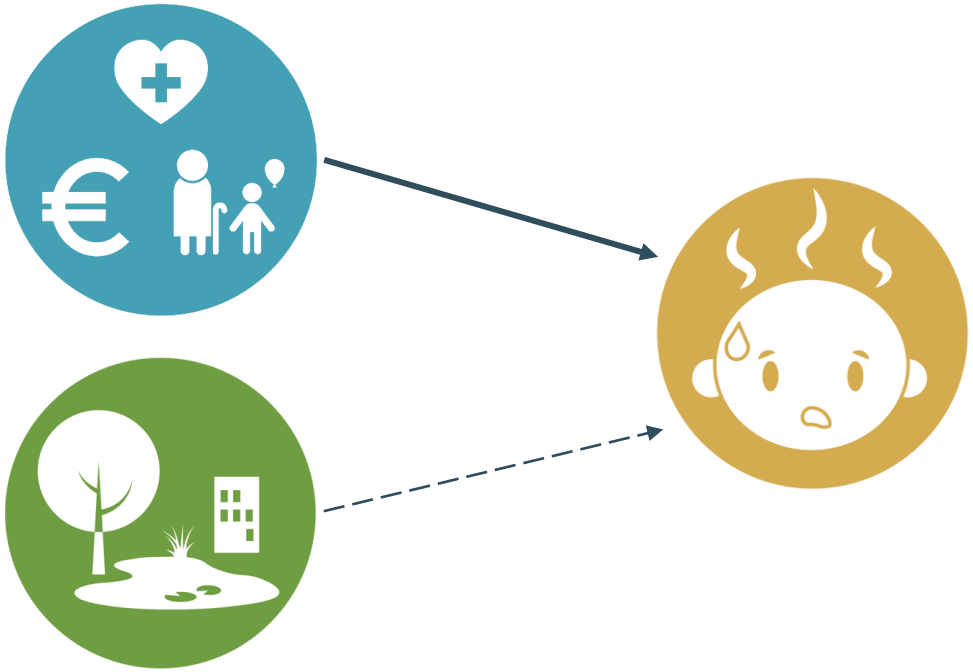
Thermal comfort survey

Perceived stress scale [PSS]
Heat strain score index [HSSI]
Pittsburgh sleep quality index [PSQI]



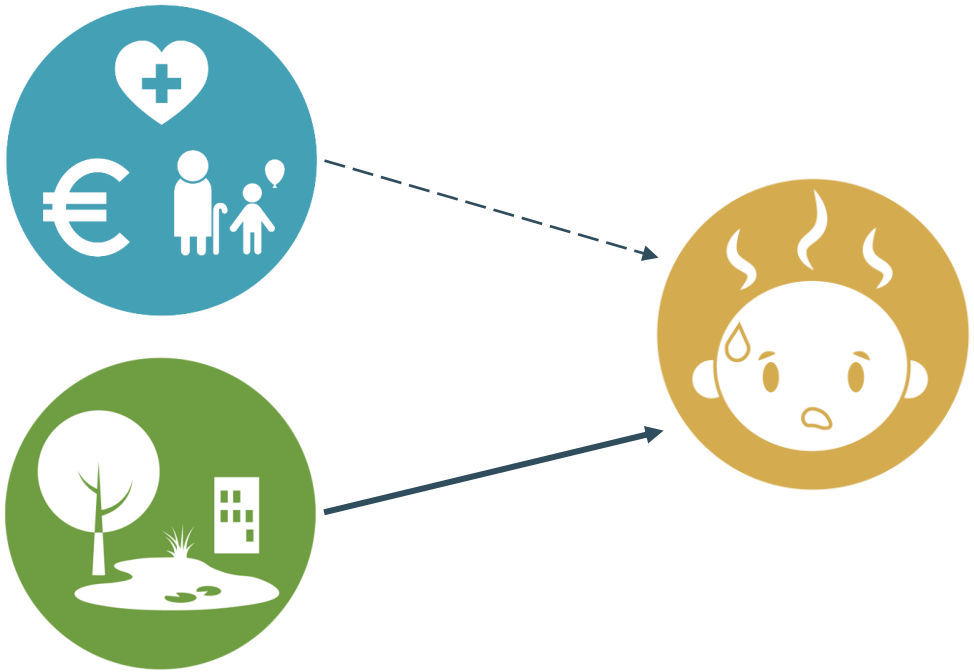
Structural equation model

CONTROL EVENT



⇨ The individual stress level is mainly associated with socio-demographic and -economic background, surrounding landscape only has minimal effects.

HEAT EVENT



⇨ Stress indicators are predominantly associated with surrounding green space. High green mitigates heat stress, low green mitigates heat stress and enhances sleep quality.

Questions?

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