Urban forests or urban savannas?

Tailoring cooling strategies to spatial and temporal variability in urban environments

MPD2 Green, blue and brown infrastructures - ICUC12-731

Eva Beele - Raf Aerts - Maarten Reyniers - Ben Somers
July 11th, 2025

SCREEN CAPTURE WELCOME

CLIMATE CHANGE

URBANIZATION

HUMAN HEALTH RISKS

URBAN GREEN AS NATURE-BASED SOLUTION?

Icons: Flaticon.com

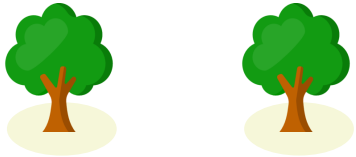
Eva Beele (eva.beele@kuleuven.be) - Division Forest, Nature and Landscape

URBAN GREEN SPACES AS NATURE-BASED SOLUTION?

A

TYPE ≈ Urban green type  OR 

HOW MUCH ≈ Urban green composition  OR 

WHERE ≈ Urban green configuration  OR 

B

DIFFERENT ACROSS DISTINCT LOCATIONS IN THE CITY?

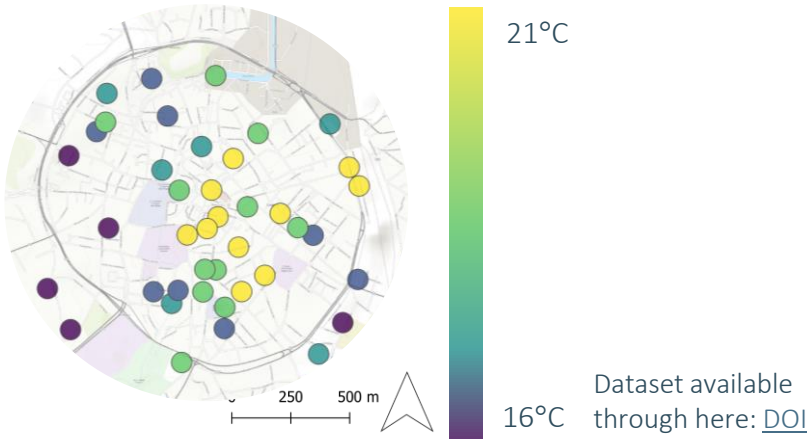
Icons: Flaticon.com

Eva Beele (eva.beele@kuleuven.be) - Division Forest, Nature and Landscape

KU LEUVEN

1 Crowdsourced air temperature data

- Leuven.cool citizen network of low-cost weather stations
- Quality controlled and bias-corrected temperature data
- Mean night and day temperatures



Dataset available through here: DOI

2 Urban land cover data

- Trees – grasses & shrubs – impervious - buildings
- Relative cover – aggregation (AI) – shape (SH)

3 Multiple linear mixed models

Eva Beele (eva.beele@kuleuven.be) - Division Forest, Nature and Landscape

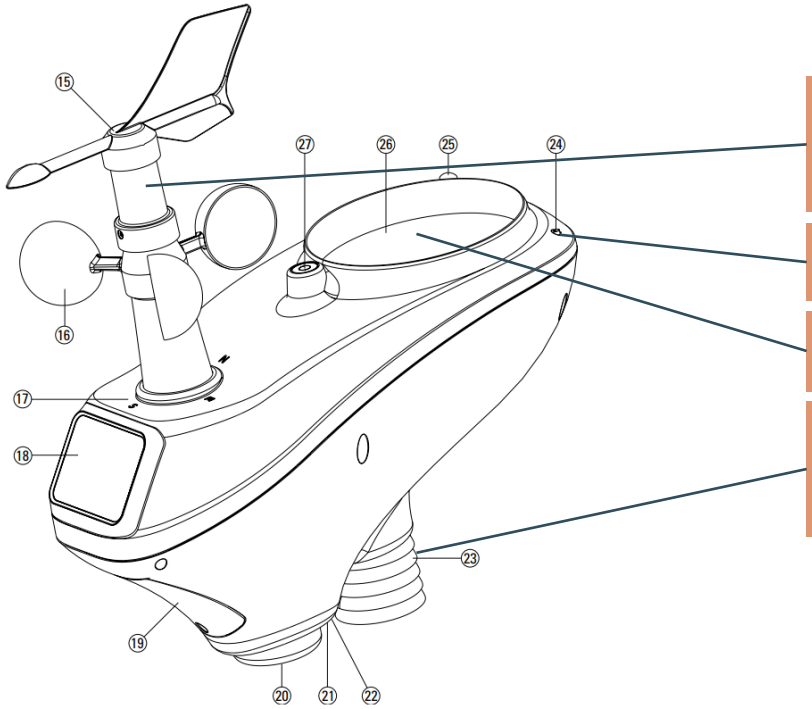
KU LEUVEN

Leuven.cool – crowdsourced air temperature

Collaboration between KU Leuven - RMI - the city of Leuven

⇨ Measure the micro-climate in Leuven and investigate the mitigating effects of urban green spaces, both in public spaces and in private gardens of citizens

Fine Offset WH2600



- Wind direction
  Wind speed
- Radiation
- Rainfall
- Temperature
  Relative humidity

Eva Beele (eva.beele@kuleuven.be) - Division Forest, Nature and Landscape

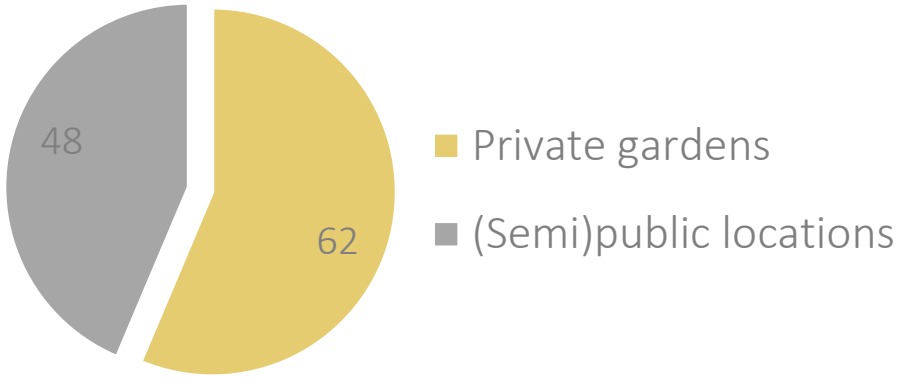
KU LEUVEN

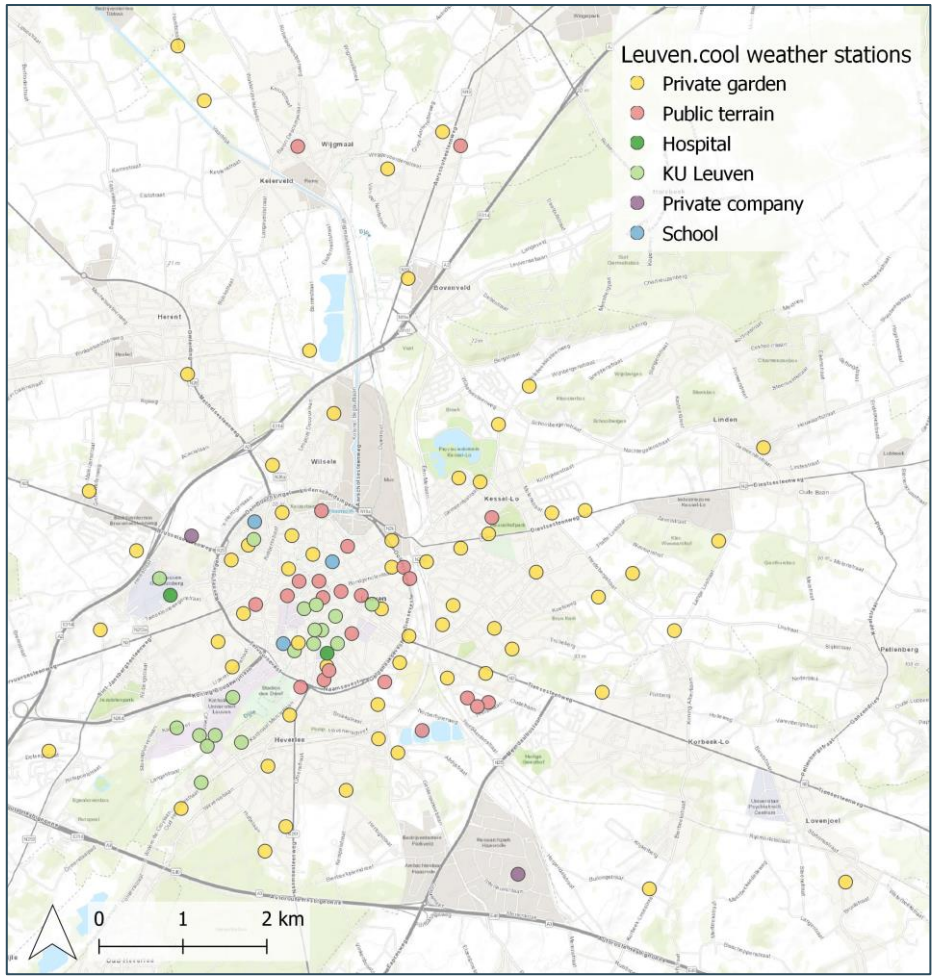
Leuven.cool – crowdsourced air temperature

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





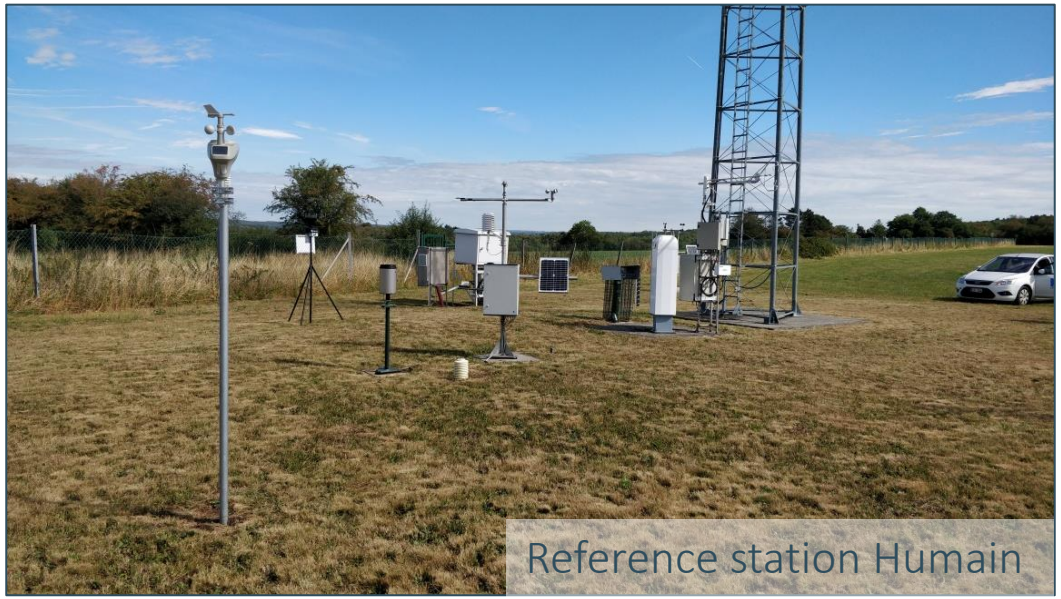
Eva Beele (eva.beele@kuleuven.be) - Division Forest, Nature and Landscape

KU LEUVEN

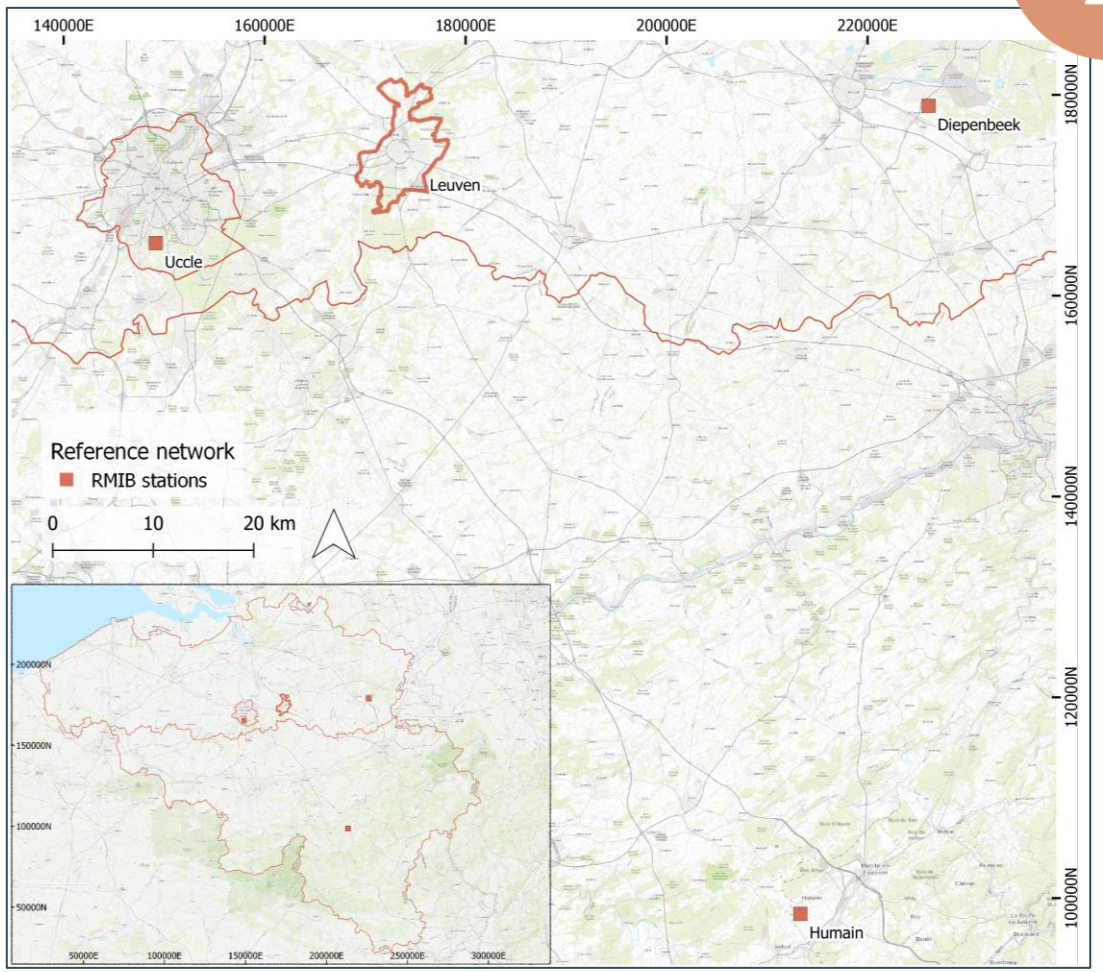
Leuven.cool – crowdsourced air temperature

The complete Leuven.cool network consists of 114 weather stations

- 110 base stations
- 4 reference stations



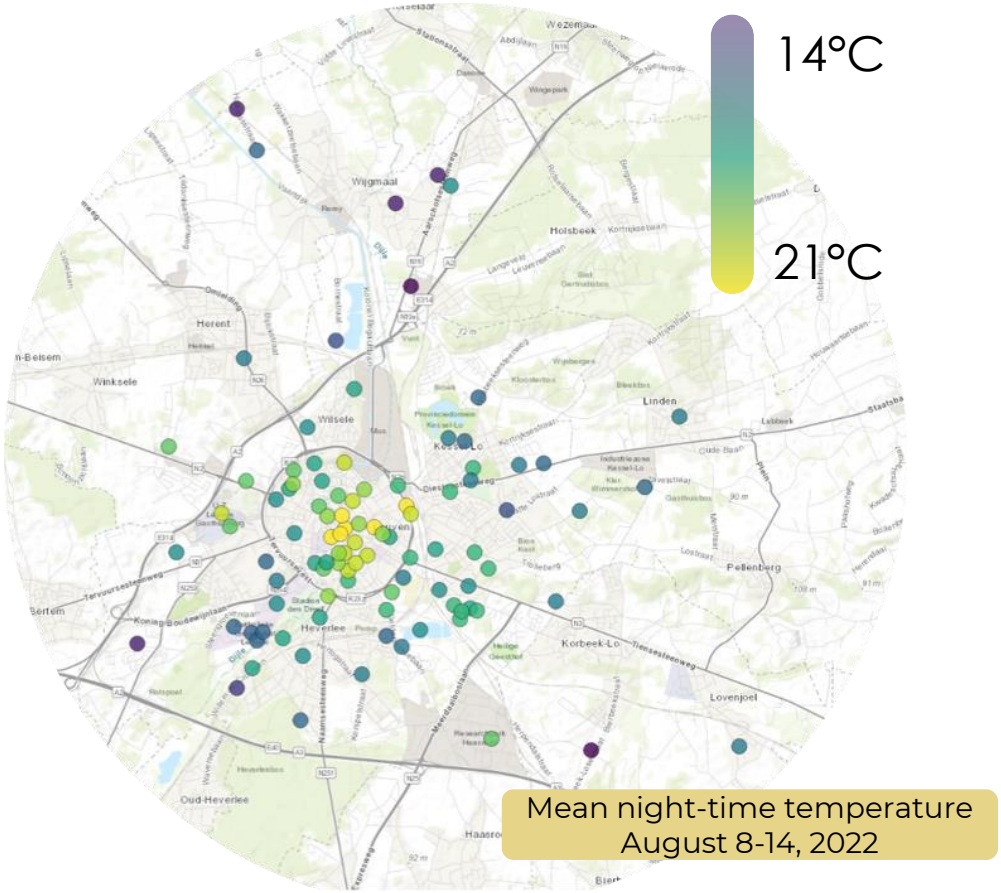
Reference station Humain



Eva Beele (eva.beele@kuleuven.be) - Division Forest, Nature and Landscape

KU LEUVEN

Leuven.cool – urban heat island



Mean night-time temperature
August 8-14, 2022

Mean day and night temperatures

- June 13-19 , 2022
- July 13-19 , 2022
- August 8-17, 2022

Leuven.cool data download

zenodo Raw data

KU LEUVEN RDR RESEARCH DATA REPOSITORY Quality controlled and corrected data

Earth System Science Data Data paper

Eva Beele (eva.beele@kuleuven.be) - Division Forest, Nature and Landscape

KU LEUVEN

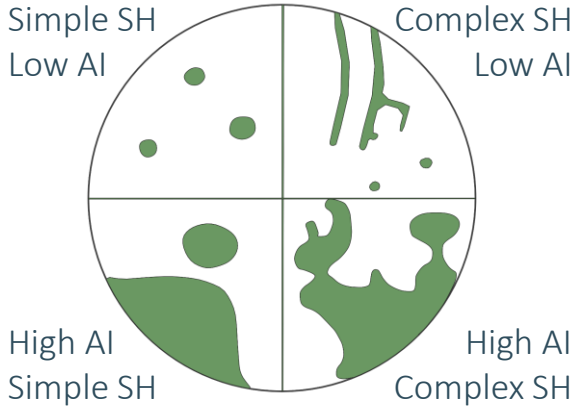
1 Crowdsourced air temperature data

- Leuven.cool citizen network of low-cost weather stations
- Quality controlled and bias-corrected temperature data
- Mean night and day temperatures

Dataset available through here: DOI

2 Urban land cover data

- Trees – grasses & shrubs – impervious - buildings
- Relative cover – aggregation (AI) – shape (SH)



3 Multiple linear mixed models

Eva Beele (eva.beele@kuleuven.be) - Division Forest, Nature and Landscape

KU LEUVEN

Urban green space

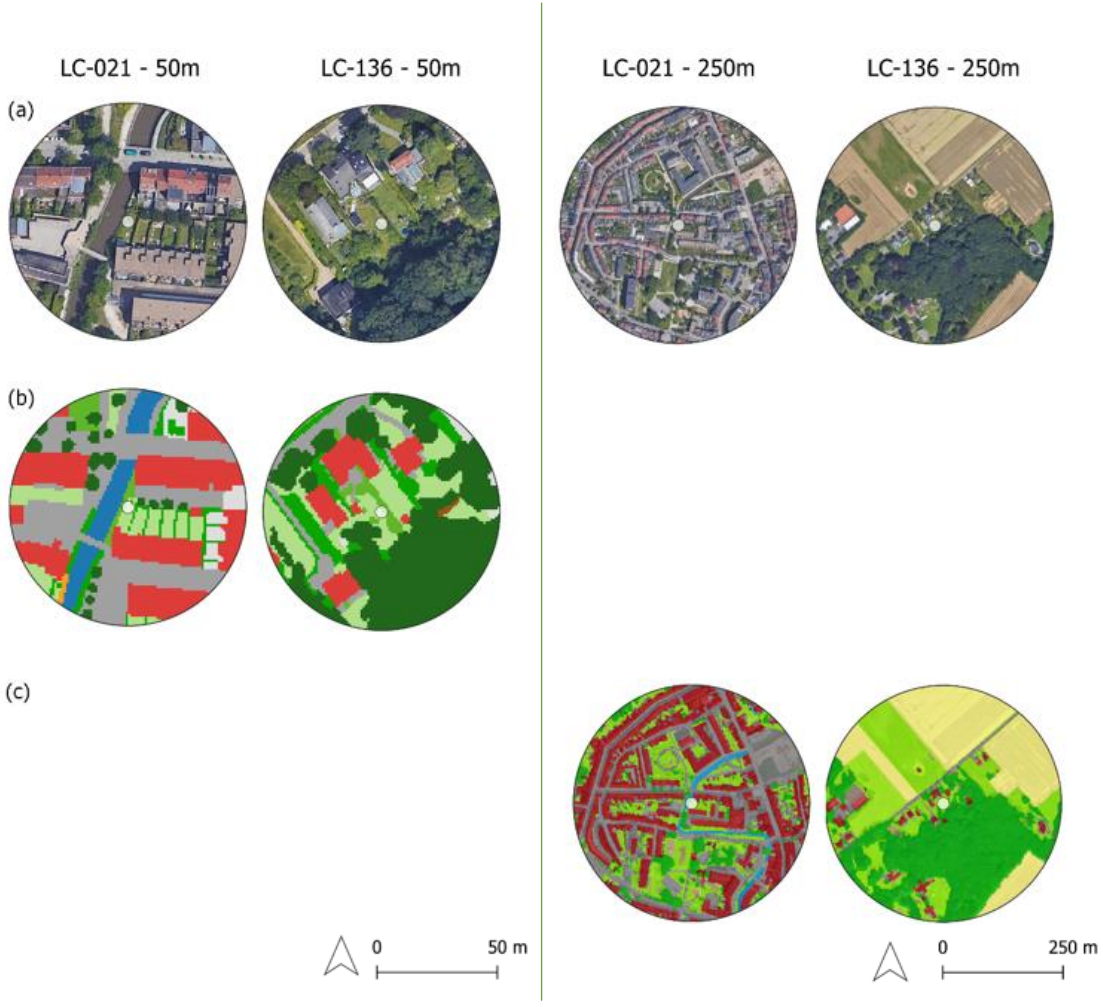
Characterize land cover around weather stations

Characterize land cover around weather stations

- Field inventories
- Remote sensing data

Simplification of land cover:

- **Trees**
- **Grasses and shrubs**
- Buildings
- Impervious



Eva Beele (eva.beele@kuleuven.be) - Division Forest, Nature and Landscape

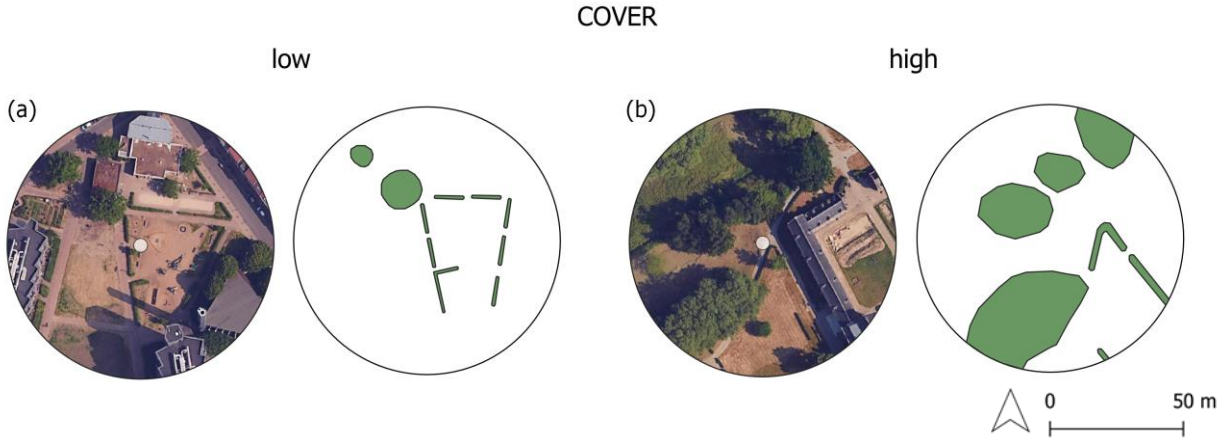
KU LEUVEN

Urban green space

Green space composition

Quantify land cover around weather stations using 3 metrics:

- Relative cover
- Aggregation ↔ Fragmentation
- Shape



Eva Beele (eva.beele@kuleuven.be) - Division Forest, Nature and Landscape

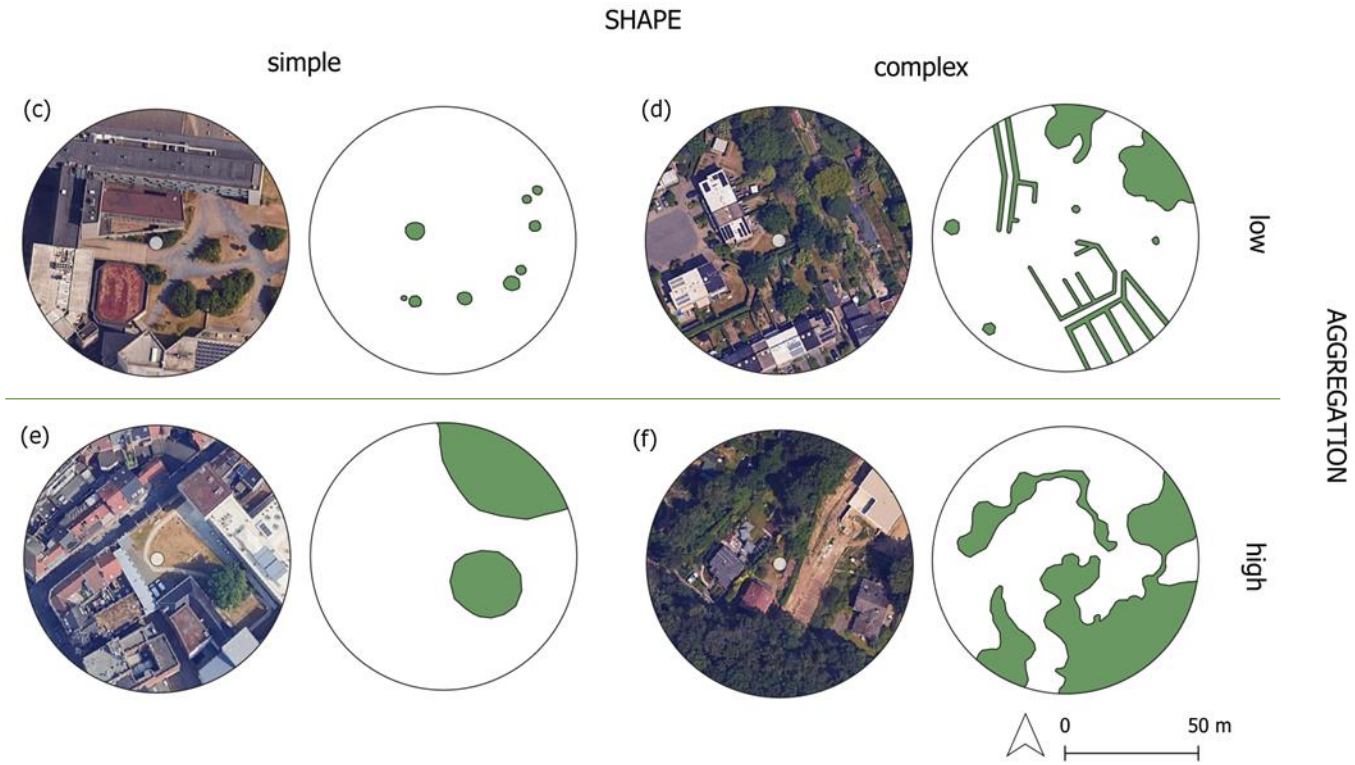
KU LEUVEN

Urban green space

Quantify land cover around weather stations using 3 metrics:

- Relative cover
- Aggregation ↔ Fragmentation
- Shape

Green space configuration



Eva Beele (eva.beele@kuleuven.be) - Division Forest, Nature and Landscape

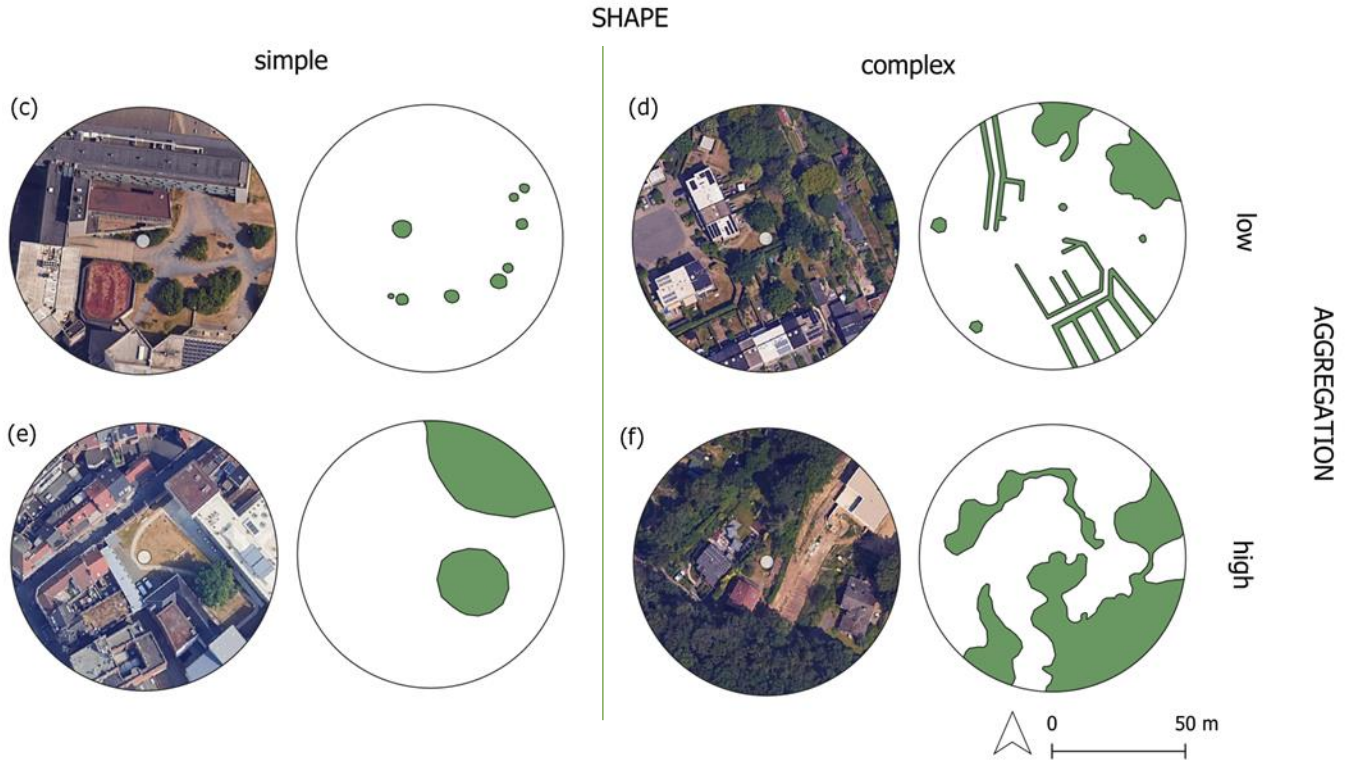
KU LEUVEN

Urban green space

Quantify land cover around weather stations using 3 metrics:

- Relative cover
- Aggregation ↔ Fragmentation
- Shape

Green space configuration



Eva Beele (eva.beele@kuleuven.be) - Division Forest, Nature and Landscape

KU LEUVEN

1 Crowdsourced air temperature data

- Leuven.cool citizen network of low-cost weather stations
- Quality controlled and bias-corrected temperature data
- Mean night and day temperatures

Dataset available through here: DOI

2 Urban land cover data

- Trees – grasses & shrubs – impervious - buildings
- Relative cover – aggregation (AI) – shape (SH)

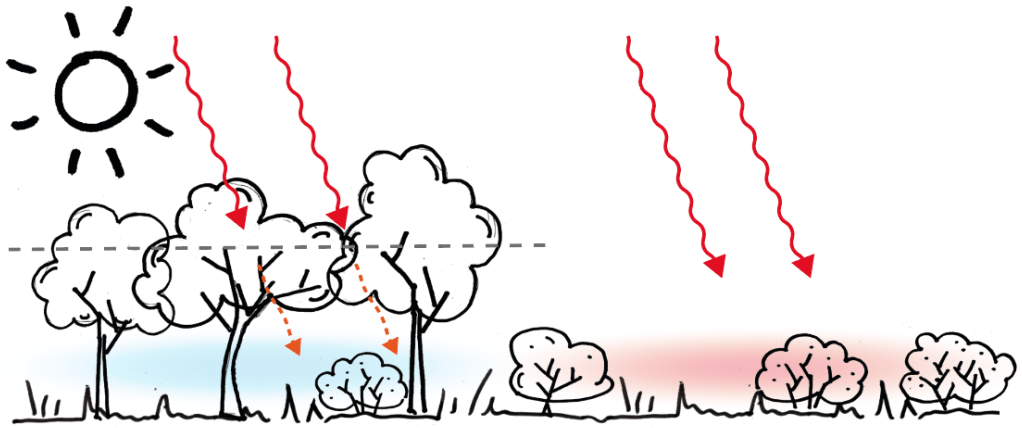
3 Multiple linear mixed models

Eva Beele (eva.beele@kuleuven.be) - Division Forest, Nature and Landscape

KU LEUVEN

A Green space cooling: relative cover

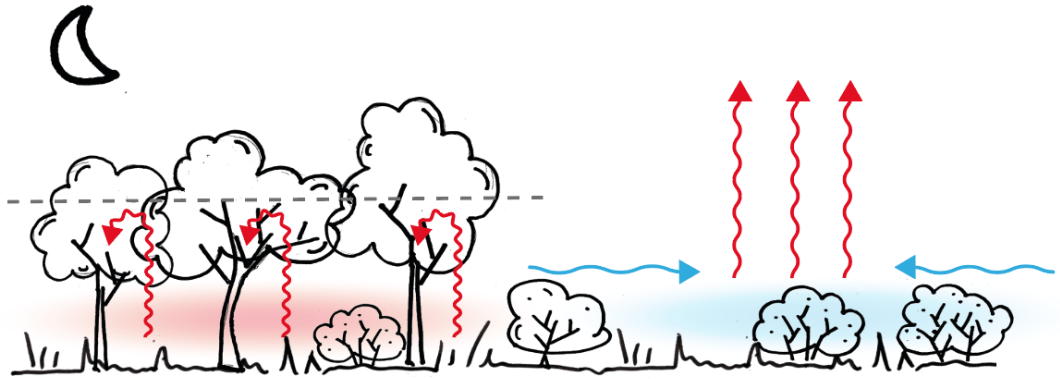
Cooling during daytime



10% ↑ trees	0.10°C ↓
10% ↑ grasses and shrubs	-

Trees provide more cooling compared to grasses and shrubs
⇨ Cooling due to transpiration and shadow

Cooling at night



10% ↑ trees	0.20°C ↓
10% ↑ grasses and shrubs	0.50°C ↓

Grasses and shrubs provide more cooling compared to trees
⇨ Cooling due to long-wave radiation loss & ventilation

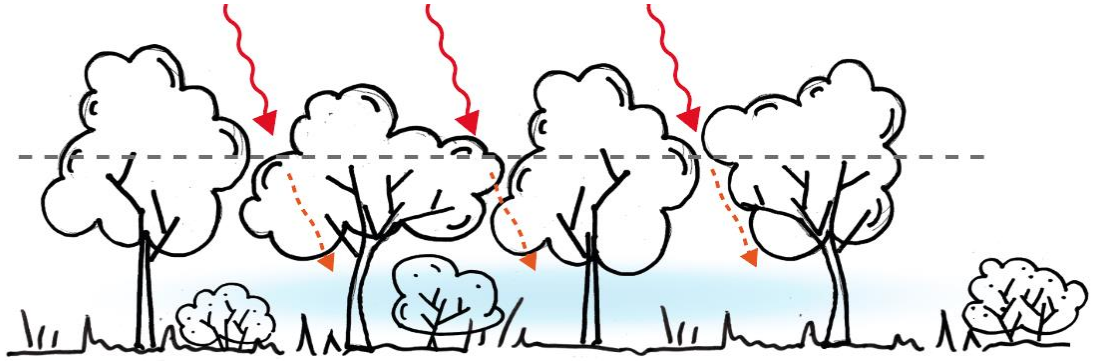
Figures: Tom Beele

Eva Beele (eva.beele@kuleuven.be) - Division Forest, Nature and Landscape

KU LEUVEN

A Green space cooling: aggregation & shape complexity

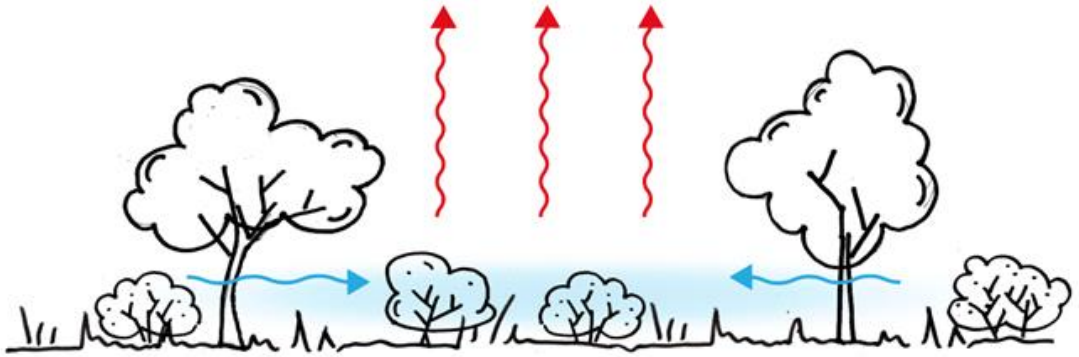
Cooling during daytime



↑ aggregation trees	0.40°C ↓
↑ aggregation grasses and shrubs	-
↑ complexity trees	-
↑ complexity grasses and shrubs	-

⇨ Urban forest:
Interconnected trees

Cooling at night



↑ aggregation trees	-
↑ aggregation grasses and shrubs	0.20-1.60°C ↓
↑ complexity trees	0.45°C ↓
↑ complexity grasses and shrubs	0.20-1.50°C ↓

⇨ Urban savanna:
Interconnected grasses and shrubs + distinctive stand-alone trees

Figures: Tom Beele

Eva Beele (eva.beele@kuleuven.be) - Division Forest, Nature and Landscape

KU LEUVEN

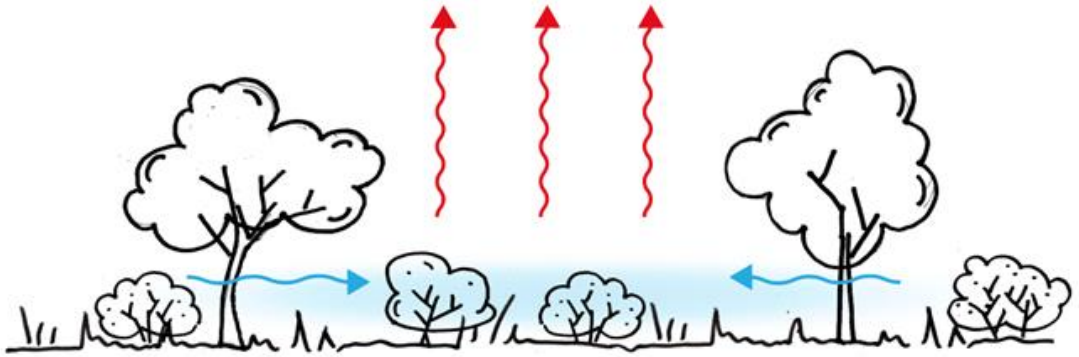
A Green space cooling: aggregation & shape complexity

Cooling during daytime

⇨ Urban forest:
Interconnected trees

≠

Cooling at night



⇨ Urban savanna:
Interconnected grasses and shrubs + distinctive stand-alone trees

Figures: Tom Beele

Eva Beele (eva.beele@kuleuven.be) - Division Forest, Nature and Landscape

KU LEUVEN

B Green space cooling for specific locations

Location-specific results:

- Green versus built-up locations

LC-123
Arenbergpark

LC-102
Naamsestraat

- Open versus closed locations

LC-121
Campus Heverlee

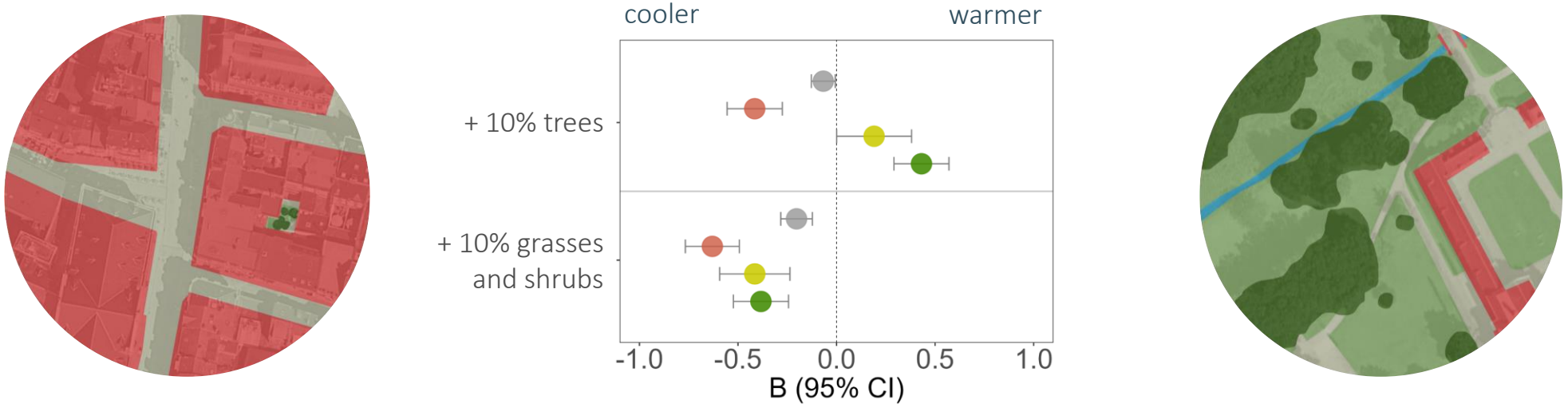
LC-113
Personeelsdienst

Eva Beele (eva.beele@kuleuven.be) - Division Forest, Nature and Landscape

KU LEUVEN

B Green space cooling for specific locations

Night-time cooling for built-up versus green locations



Cooling at night		
	Built-up	Green
10% ↑ high green	0.40°C ↓	0.20-0.45°C ↑
10% ↑ low green	0.65-1.00°C ↓	0.25-0.40°C ↓

Eva Beele (eva.beele@kuleuven.be) - Division Forest, Nature and Landscape

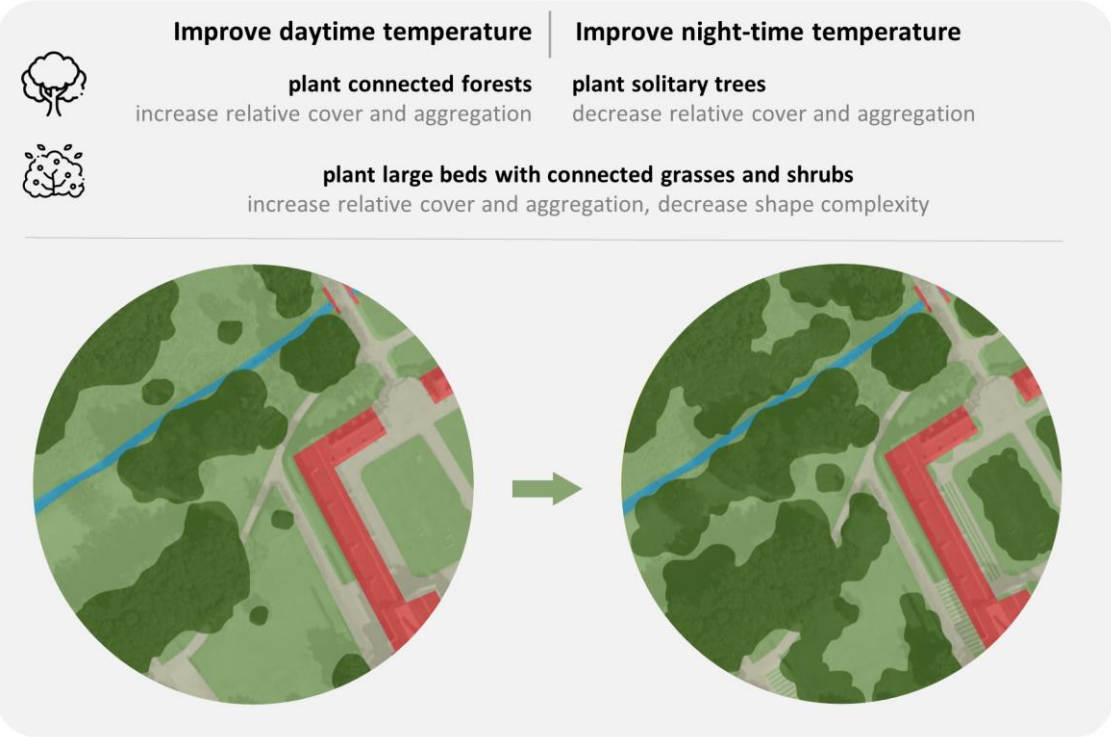
KU LEUVEN

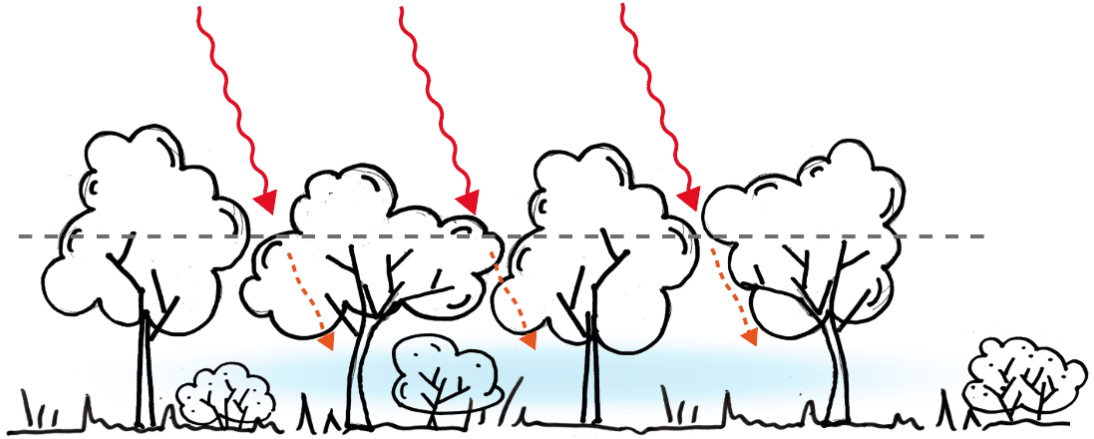
B Green space cooling for specific locations

GREEN LOCATIONS

GREENING CITIES FOR THERMAL COMFORT

Case A: Improving existing green space





URBAN FOREST

Eva Beele (eva.beele@kuleuven.be) - Division Forest, Nature and Landscape

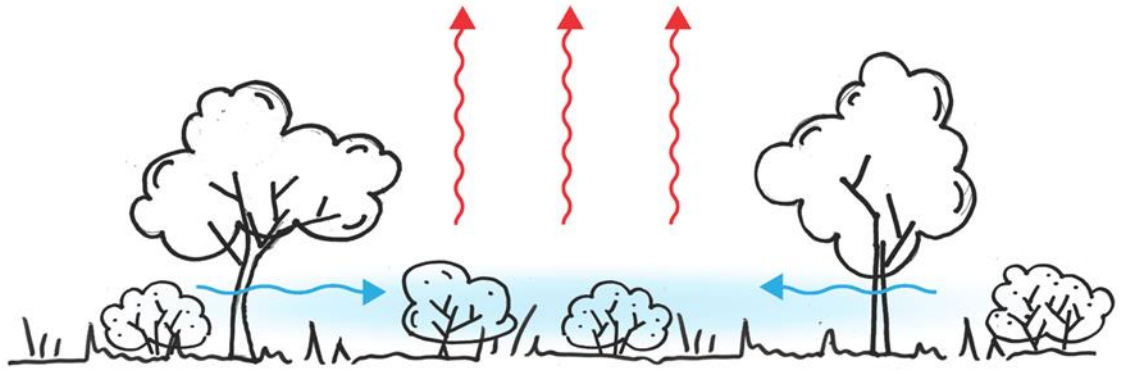
KU LEUVEN

B Green space cooling for specific locations

BUILT-UP GREY LOCATIONS

GREENING CITIES FOR THERMAL COMFORT

Case B: Creating new green space



URBAN SAVANNA

Eva Beele (eva.beele@kuleuven.be) - Division Forest, Nature and Landscape

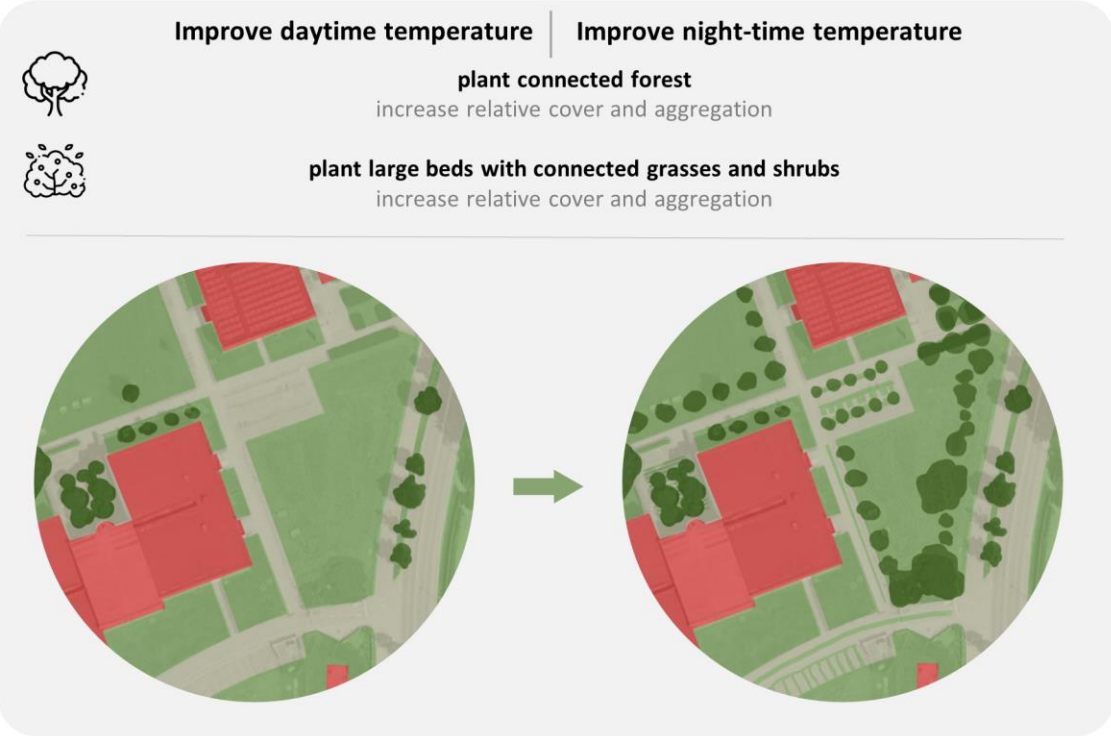
KU LEUVEN

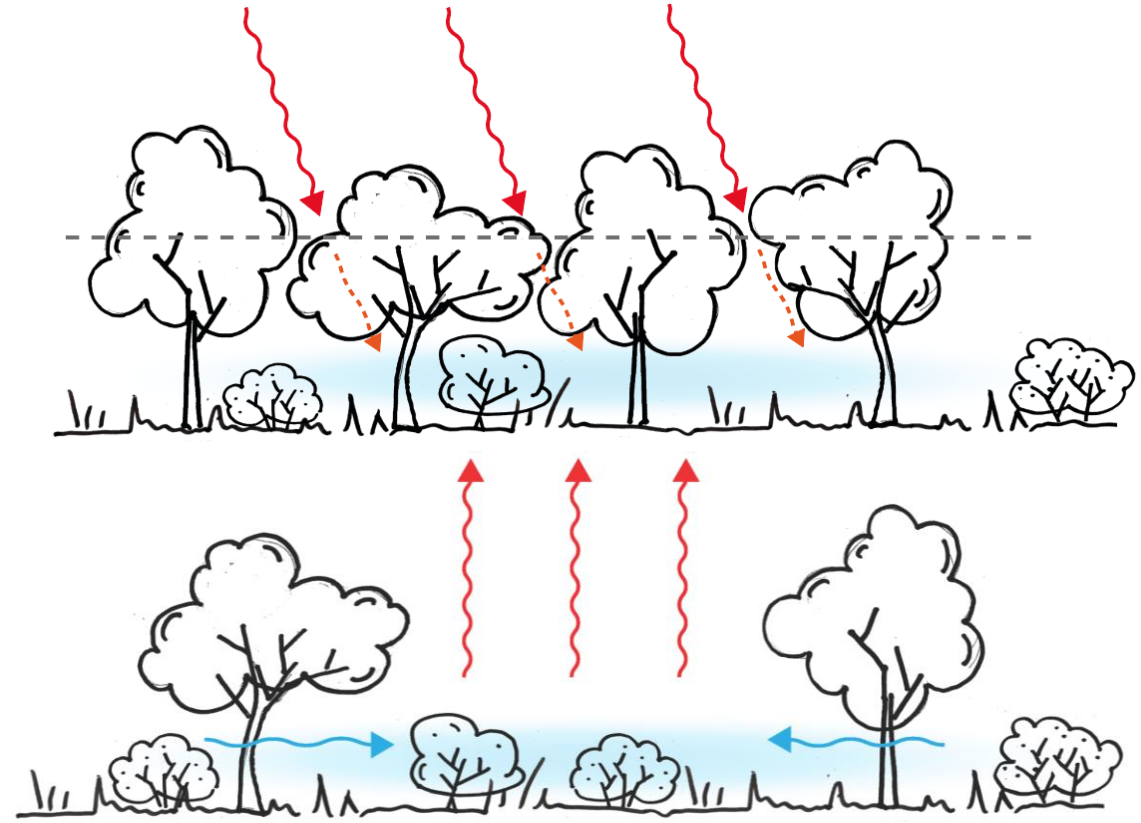
B Green space cooling for specific locations

OPEN LOCATIONS

GREENING CITIES FOR THERMAL COMFORT

Case C: Improving open locations





MIX OF URBAN FOREST AND URBAN SAVANNA

Eva Beele (eva.beele@kuleuven.be) - Division Forest, Nature and Landscape

KU LEUVEN

CONTACT
eva.beele@kuleuven.be
orcid.org/0000-0001-6838-1821
www.researchgate.net/profile/Eva-Beele
www.linkedin.com/in/eva-beele

1. Relative cover, **aggregation and shape** are important

2. Trees = daytime cooling;
   Grasses & shrubs = night-time cooling

3. There is need for context-specific strategies:
   - **Green** locations ⇨ **urban forests**
   - **Built-up grey** locations ⇨ **urban savannas**
   - **Open** locations ⇨ **mix**