A multi-level Thermal Comfort Assessment (TCA)

Identifying and mitigating heat stress risks in urban areas

Gideon Spanjar senior researcher

Amsterdam University of Applied Sciences

Co-authors proceedings: *S. Schramkó, J. Kluck, D. Bartlett, S. Erwin, D. Föllmi*

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Liveability of cities is under threat worldwide


UK is no longer a cold country and must adapt to heat, say climate scientists

Experts call on UK officials to prepare for periods of extreme heat or risk thousands of excess deaths

Extreme UK weather – live updates

Source: guardian.com

UK is no longer a cold country and must adapt to heat, say climate scientists


Delhi suffers at 49C as heatwave sweeps India

Source: bbc.com

Delhi suffers at 49°C as heatwave sweeps India


Japan swelters in its worst heatwave ever recorded

Source: bbc.com

Japan swelters in its worst heatwave ever recorded


Perth swelters through record six consecutive days over 40C temperatures

West Australian capital also setting records for most days above 40C in a summer with the tally now at 11 days

Follow our Australia news live blog for the latest updates

Download the free Guardian app; get our morning email briefing

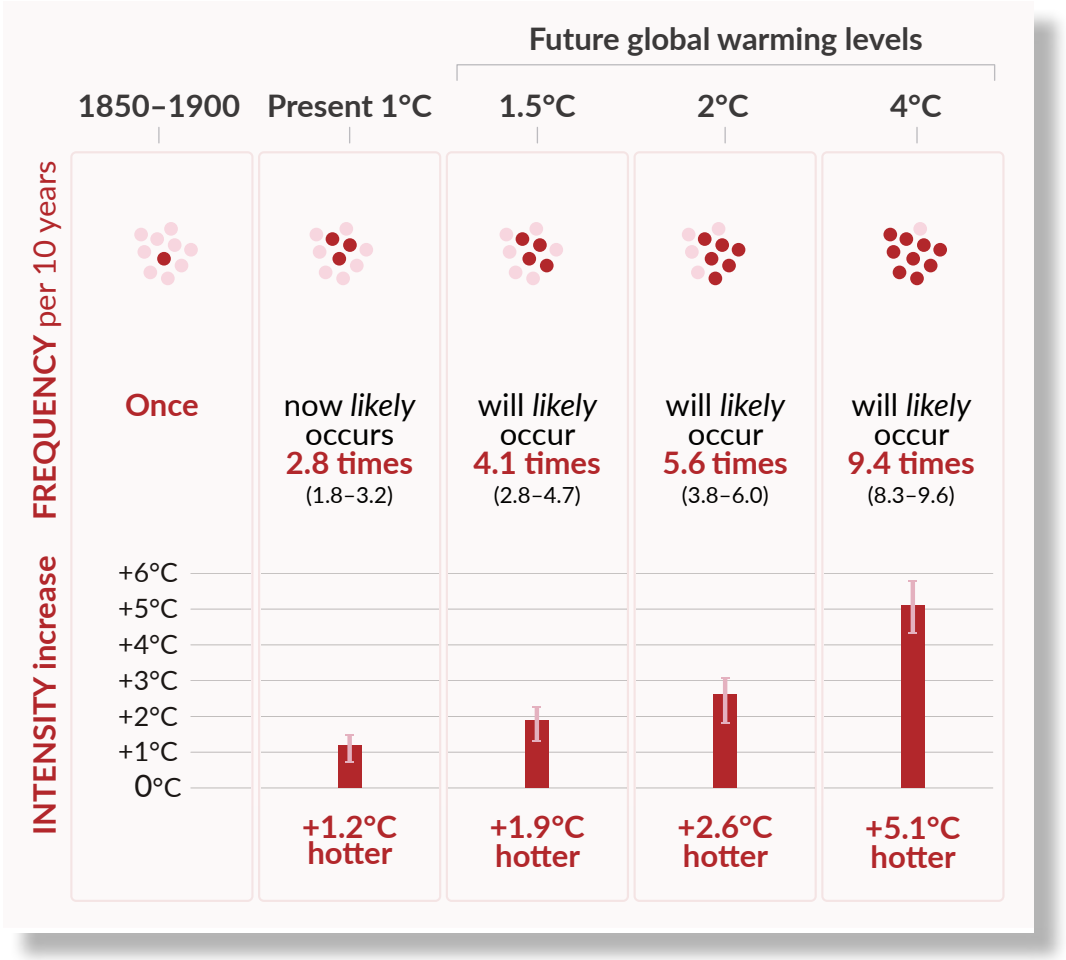
Source: guardian.com

Perth swelters through record six consecutive days over 40°C temperatures

Heat waves increase in intensity and frequency

Hot temperature extremes over land

10-year event



IPCC, 2021: Climate Change 2021: The Physical Science Basis

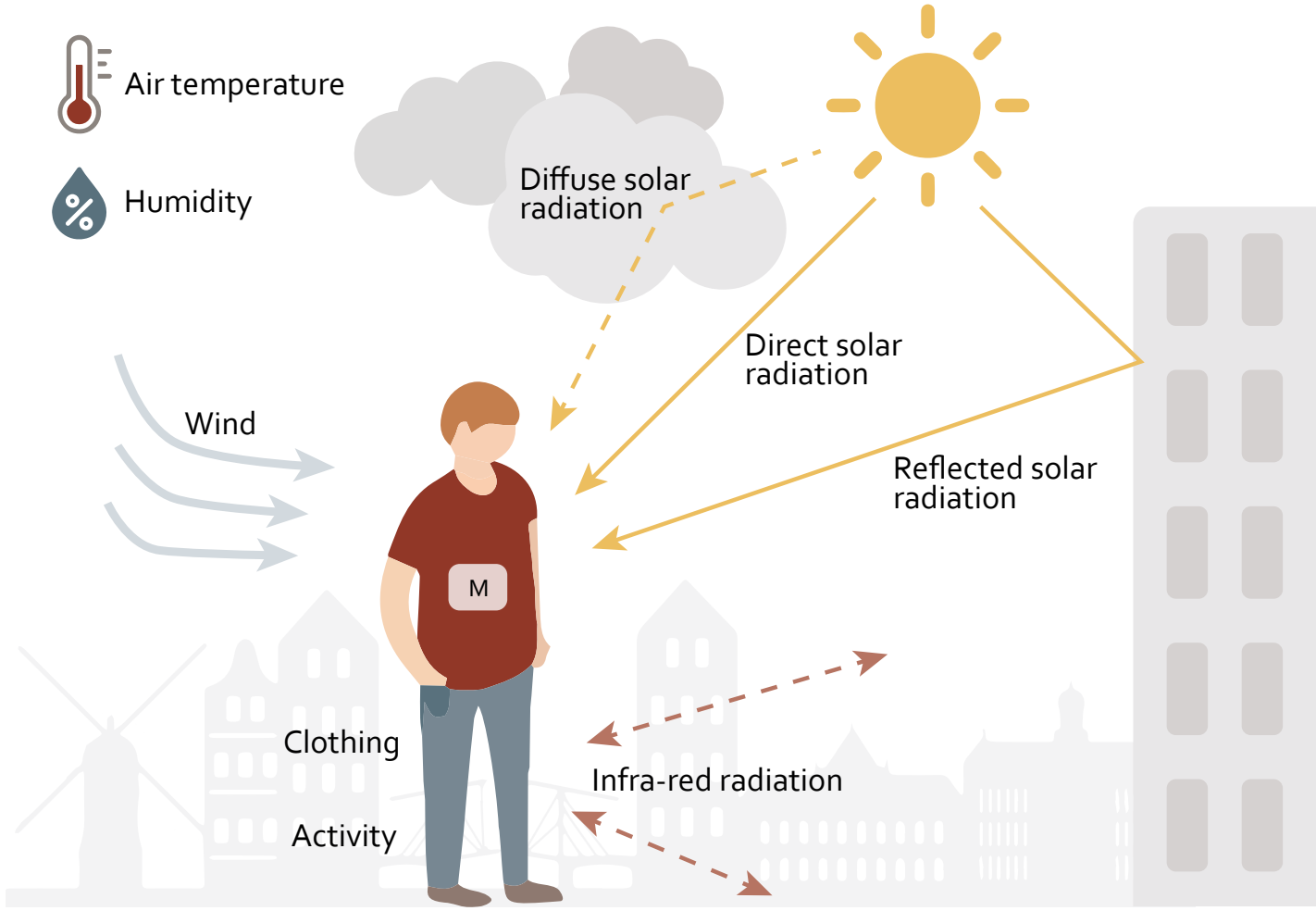
How does heat affect us?

The PET-index is based on the energy balance of the human body by using a similar indoor air temperature experience as reference (Höppe, 1999).

If, a person experiences a PET of 50°C outdoors, based on a combination of different meteorological parameters, the equivalent indoors would be an air temperature of 50°C, without the wind and solar radiation, but at the same humidity.

PET (°C)	Physiological Stress Grade
<18	Slight Cold Stress
18-23	No Thermal Stress
23-29	Slight Heat Stress
29-35	Moderate Heat Stress
35-41	Strong Heat Stress
41-46	Extreme Heat Stress (LV 1)
46-51	Extreme Heat Stress (LV 2)
51-56	Extreme Heat Stress (LV 3)
>56	Extreme Heat Stress (LV 4)

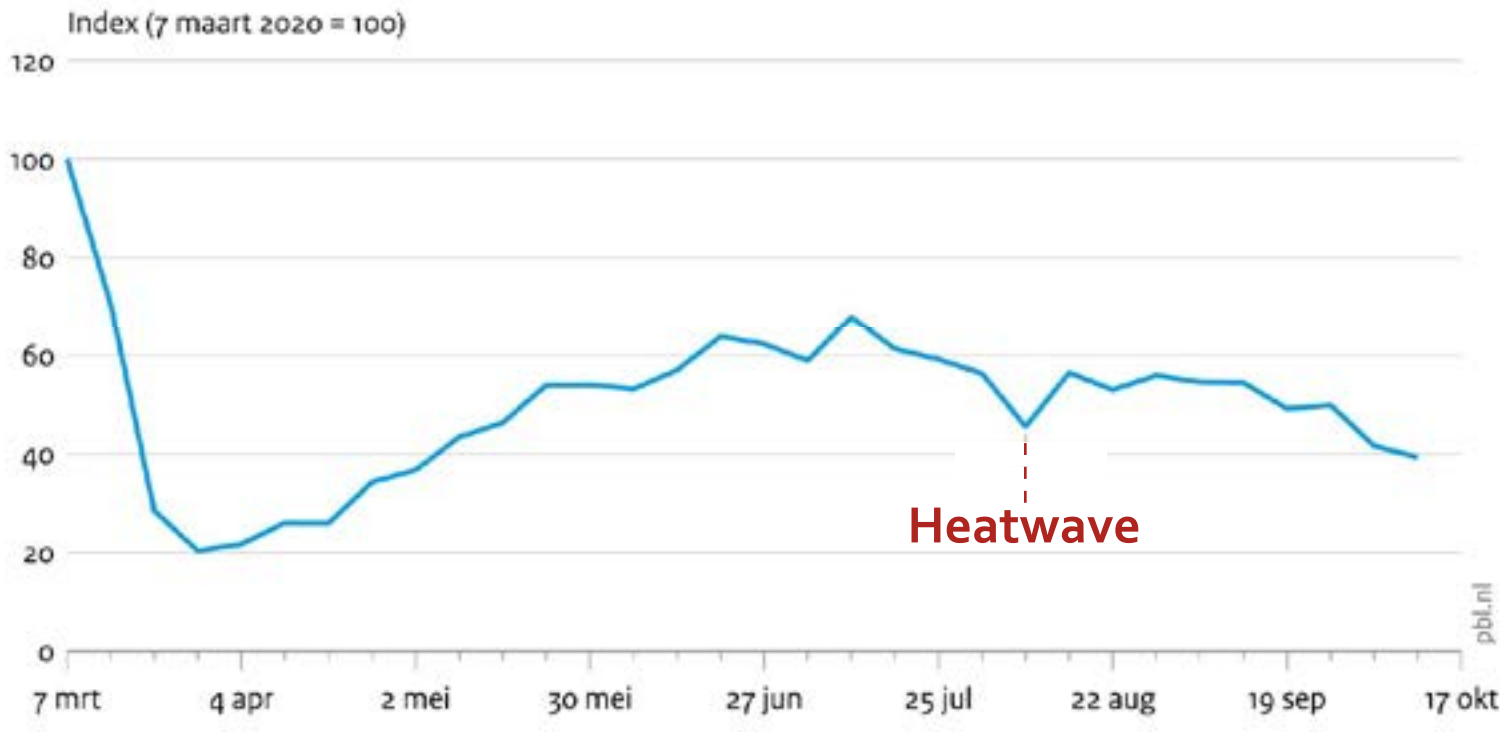
PET-index after Nouri et al. (2018), adapted from Matzarakis et al. (1999)



Adapted from Havenith (1999)

Impact of heat on the local economy

Visitors in main shopping streets on Saturday, 2020



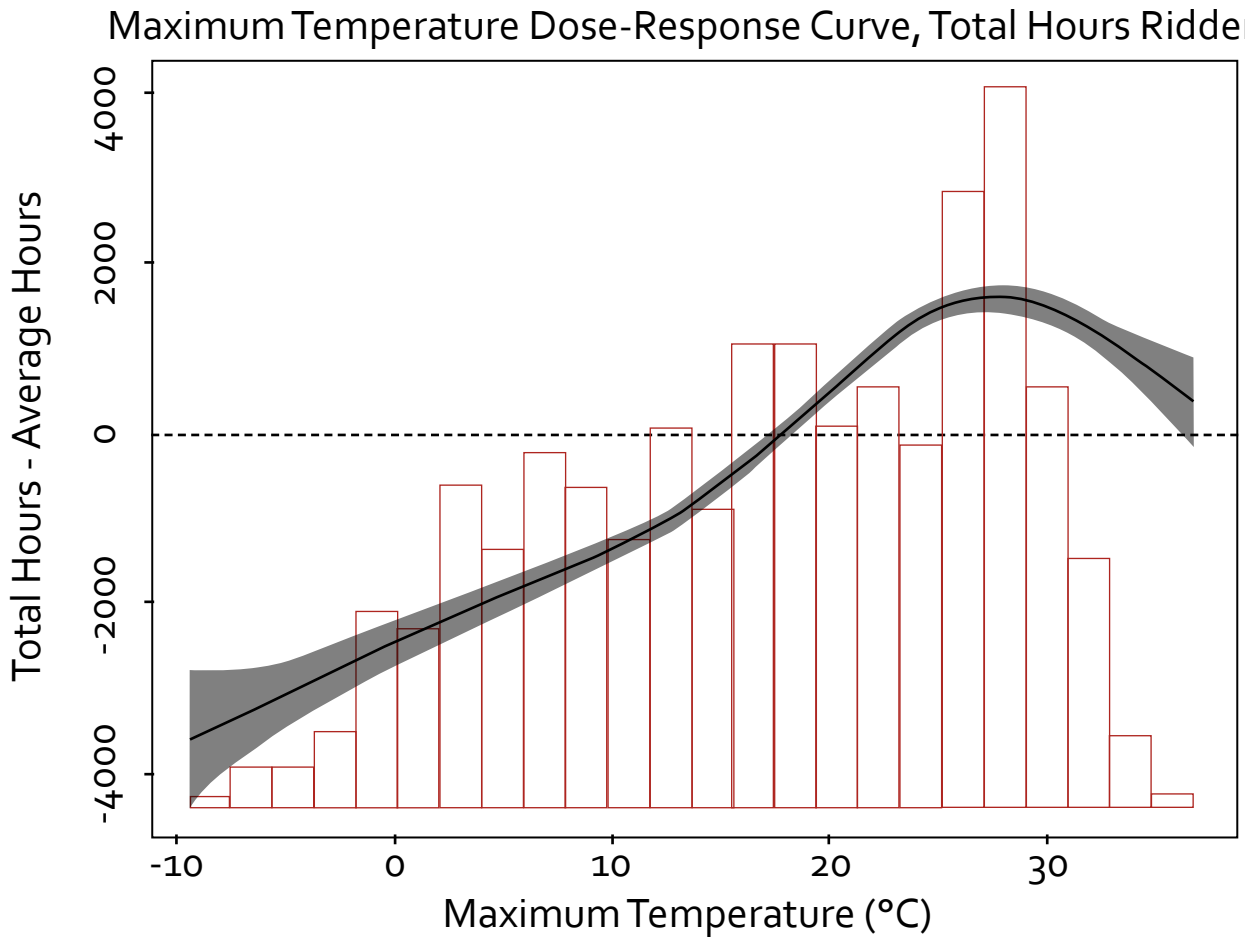
- Percentage of visitors in the busiest Dutch shopping streets
- Heat affects the local economy: drop in visitor numbers during summer heatwave in 2020

Source: PBL 2020 (Rapport: Veerkracht op de proef gesteld: Een verkenning van de impact van corona op binnensteden)

Impact of heat on mobility

Higher PET values have consequences for preferred transport modes

Adapted from: Climate Change and Physical Activity: Estimated Impacts of Ambient Temperatures on Bikeshare Usage in New York City, Heaney et al., 2019



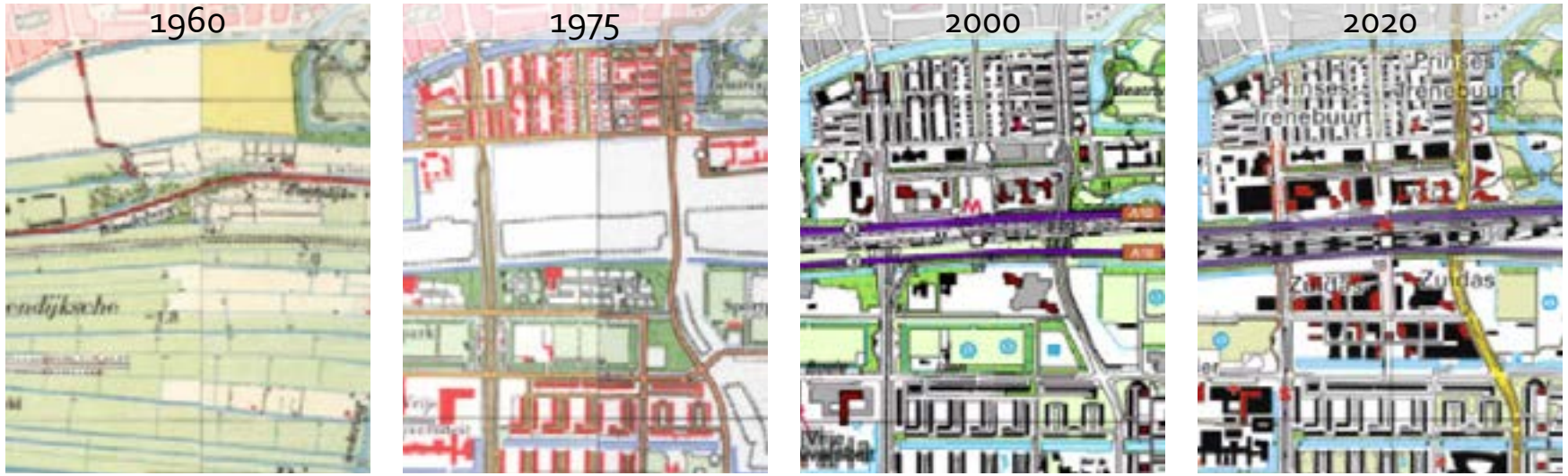
- ***Above 28°C cycling decrease***

'Of all transport modes, cycling appears to be the most sensitive to weather.'

Böcker & Thorsson, 2014

Densification of cities made us vulnerable

Example: Historical development of Zuidas



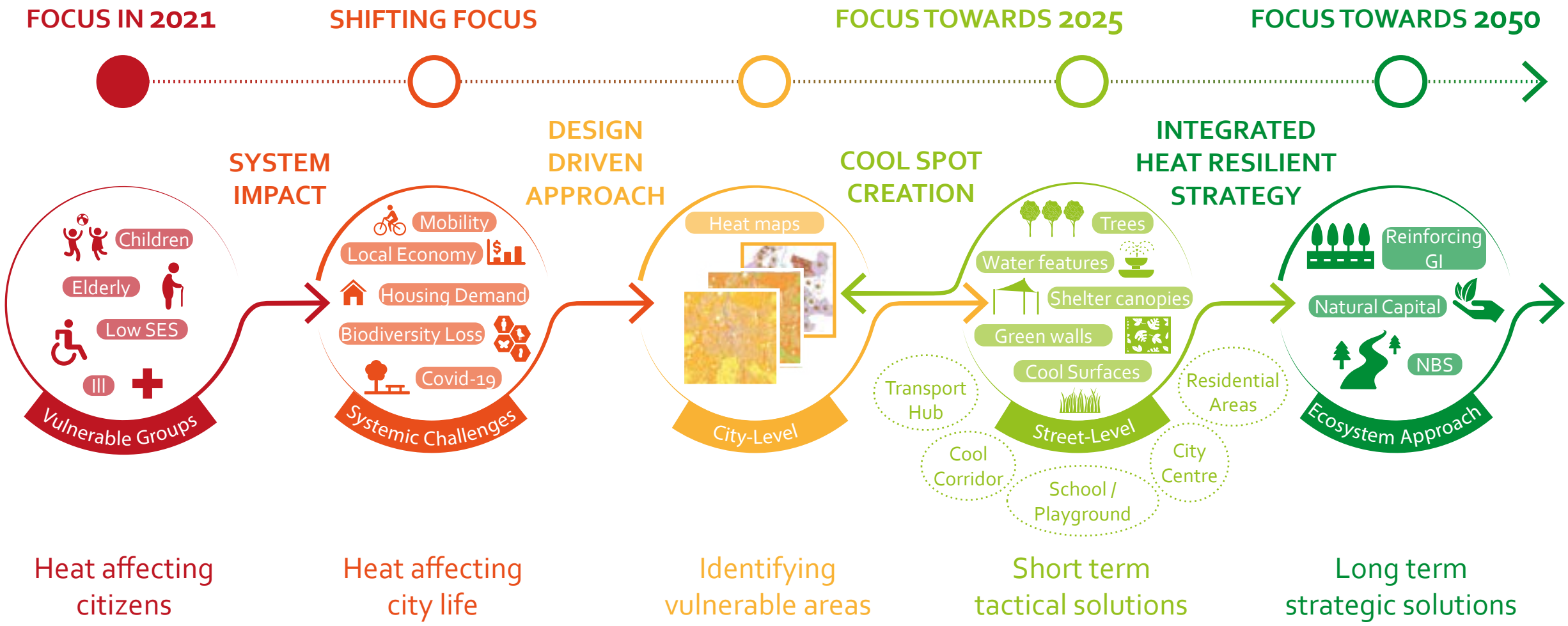
Source: topotijdreis.nl

Global challenge:
How to densify and climate proof cities?

Zuidas today

Photo: Olivier van Breugel

Tackling heat vulnerabilities = shift in focus



Cool Towns: Mitigating heat stress in cities

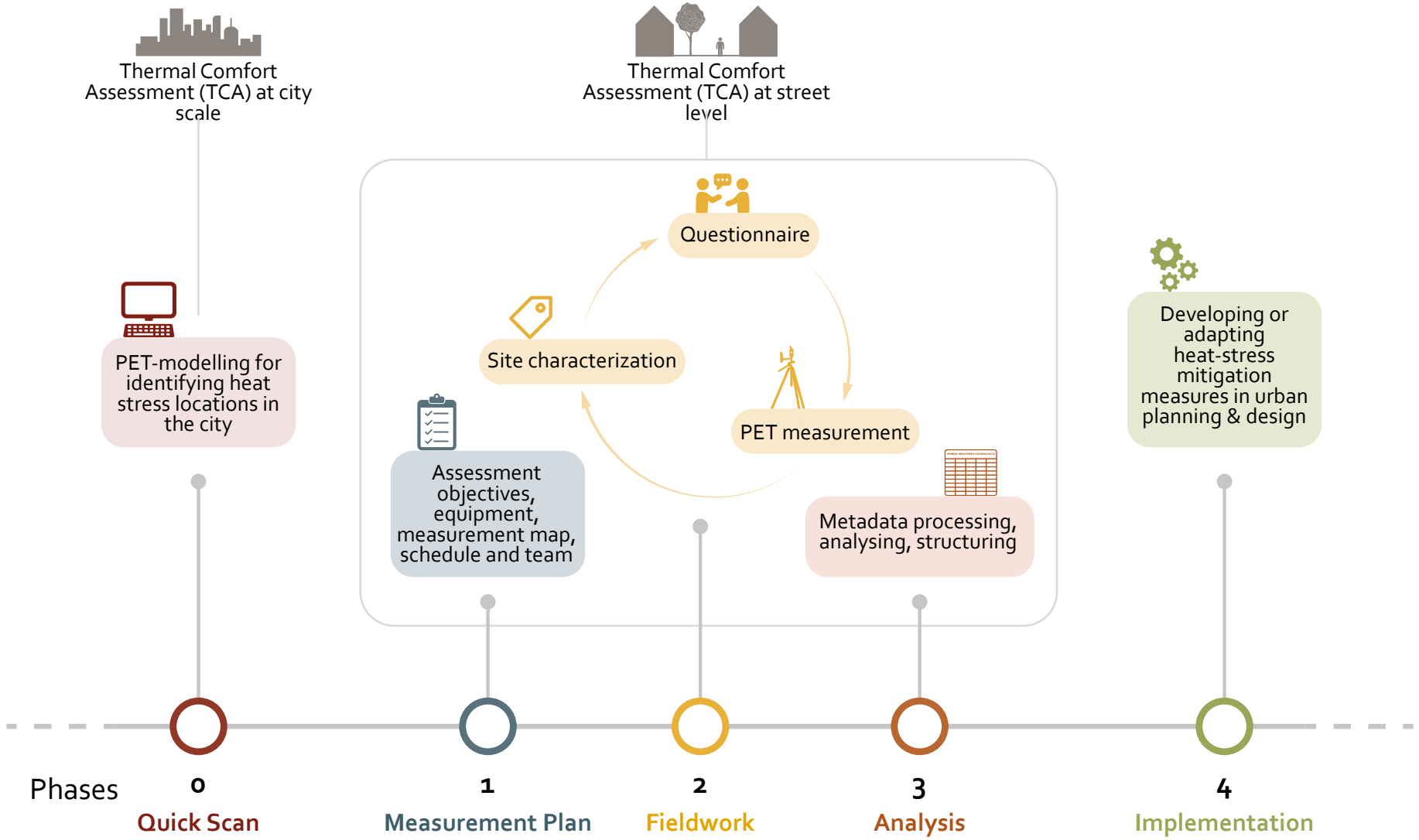
Project partners

- Municipalities & Regional authorities
- Universities
- Specialist climate adaptation companies

Project aims

- Identifying impact heat in urban areas
- Developing a decision-making toolkit for evaluating cooling measures
- Integrating heat resilience into broader climate adaptation and spatial development strategies

TCA: From problem to analysis and solutions



Source: Amsterdam University of Applied Sciences 2021

Identifying heat on city scale: Zelzate

Lunchtime Scenario

Time: 12 UTC (14 CEST), T_{air}: 28 °C

Rush Hour Scenario

Time: 15 UTC (17 CEST), Tair: 33 °C

Legend

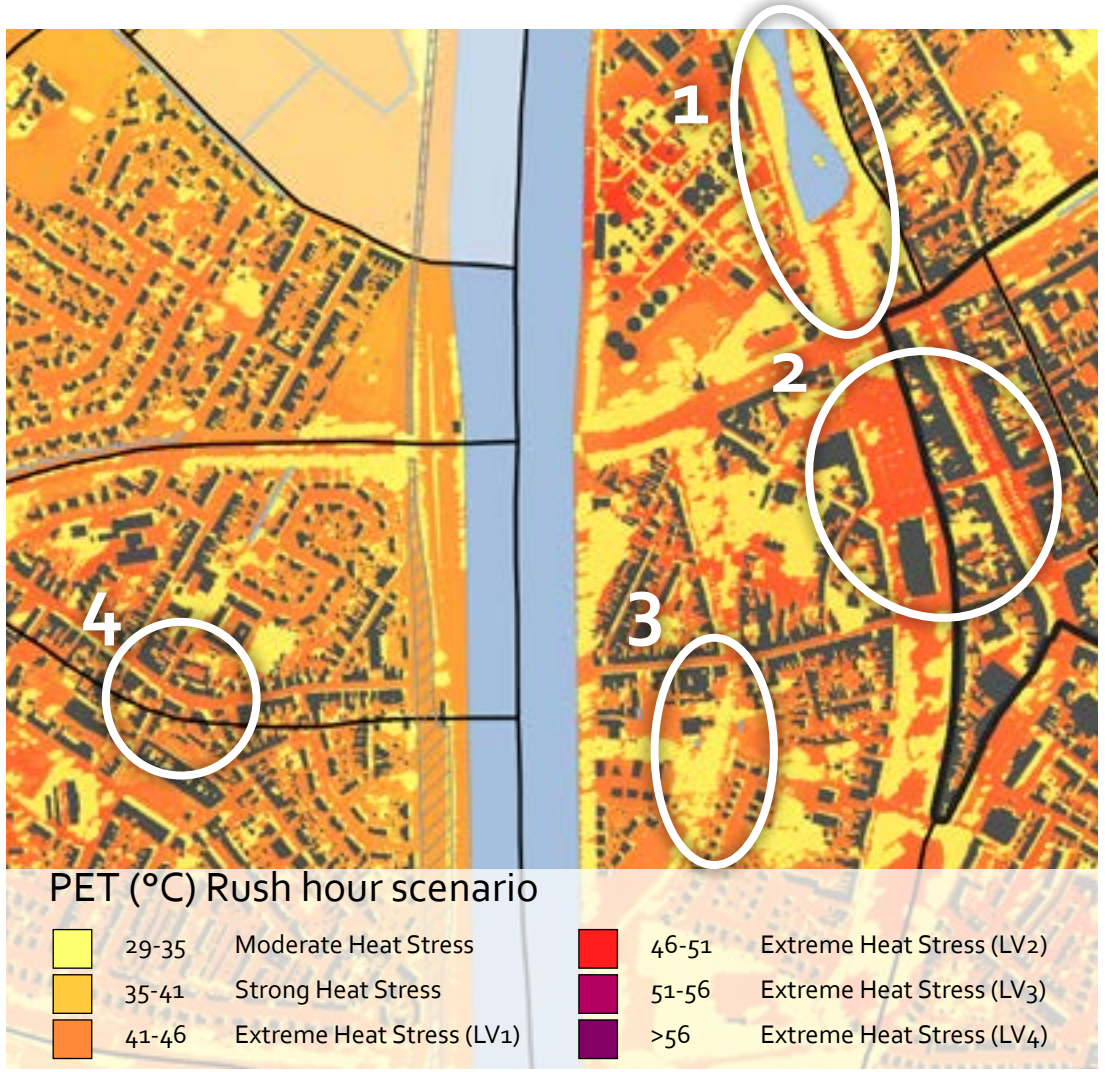
23-29	Slight Heat Stress
29-35	Moderate Heat Stress
35-41	Strong Heat Stress
41-46	Extreme Heat Stress (LV1)
46-51	Extreme Heat Stress (LV2)

- Water
- Buildings
- Neighbourhood boundaries
- Centrum

Heat stress maps used for:

- Identifying urban areas where heat mitigation interventions are most needed
- Comparing the expected effectiveness of spatial heat measures

Where do we see areas with heat stress?



1: City parks can offer a cool escape


©2022 Google, Image capture: Jun 2022

2: Transport hubs are often vulnerable locations


©2022 Google, Image capture: Sep 2021

3: Trees in a row or pocket parks can create cool routes


©2022 Google, Image capture: Jul 2018

4: Primary residential route needs shade

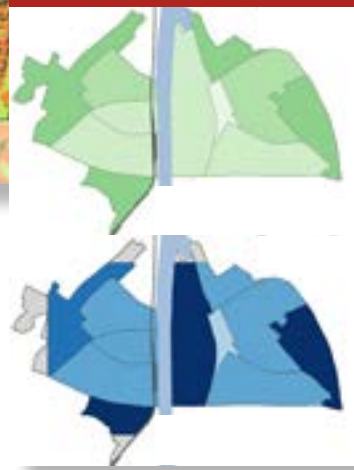

©2022 Google, Image capture: Sep 2021

Prioritizing areas: multi-level heat stress assessment

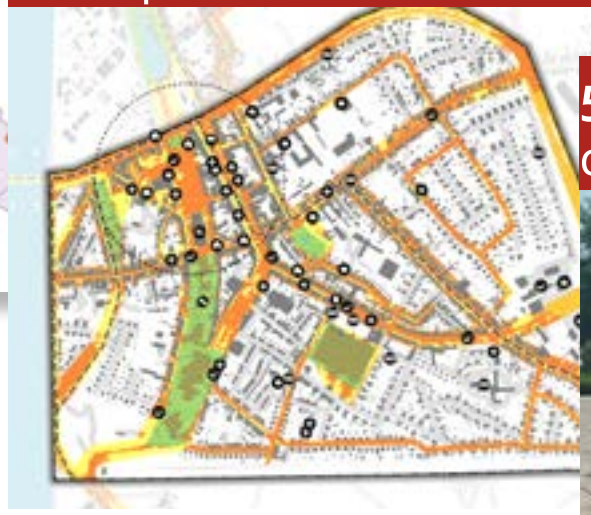
1 City level
urban planning agenda's

2 City scale heat stress area's

3 District level
social&environ. indicators



4 Neighbourhood level
heat spots and slow routes

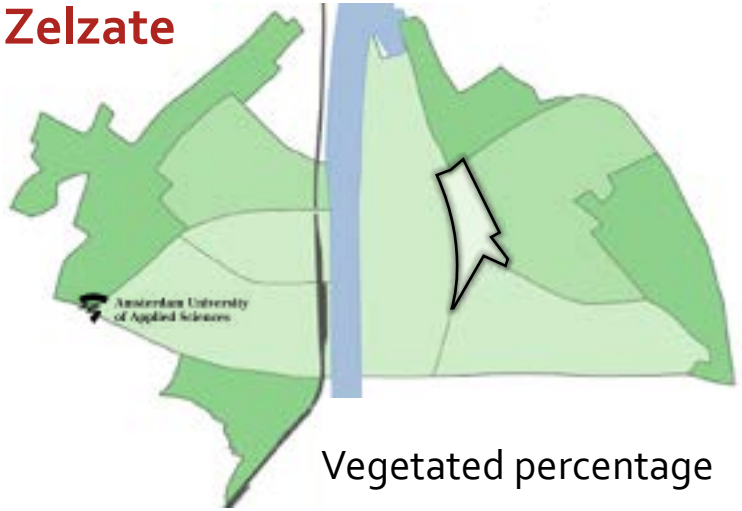


5 Street level
developing cool spots

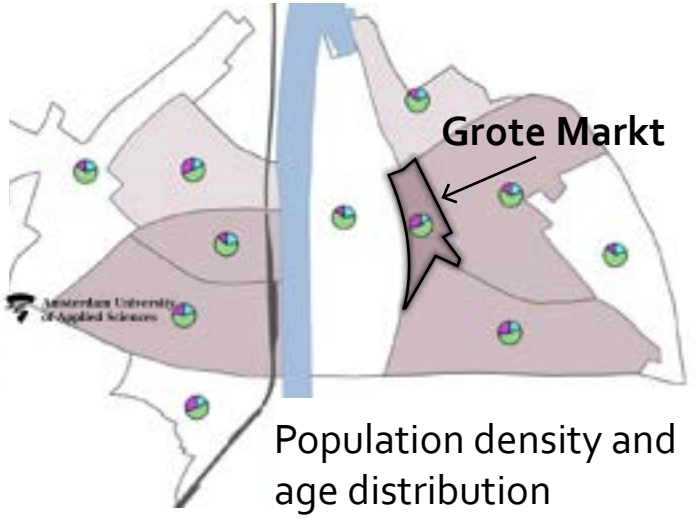
1. What are the city's priorities?
2. Where is heat stress located in the city?
3. Where is a lack of cool square meters?
4. How/what time is heat making amenities inaccessible ?
5. What is the best cool solution for the specific space?

Strategic choices: social and environmental indicators

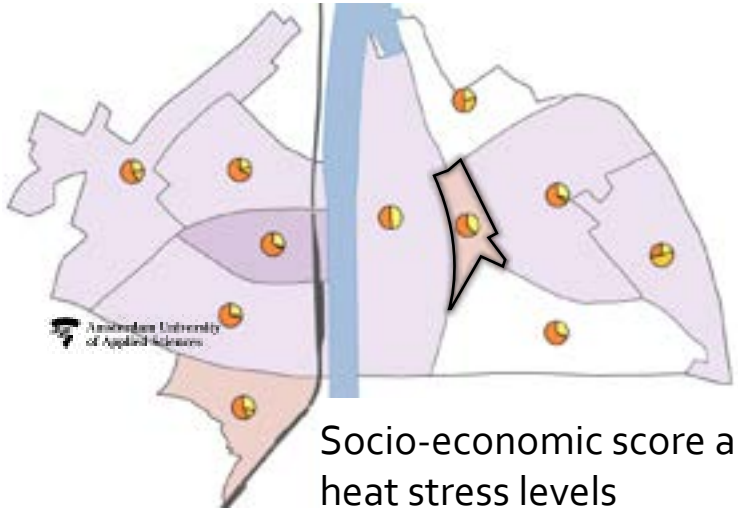
Zelzate



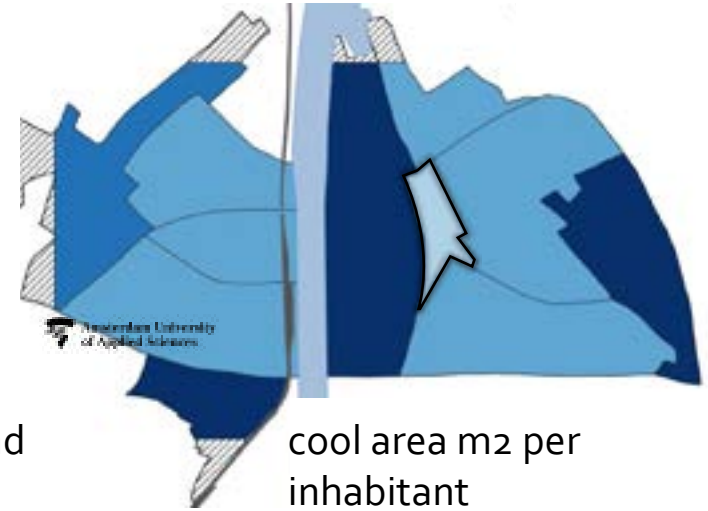
Vegetated percentage



Population density and age distribution



Socio-economic score and heat stress levels



cool area m2 per inhabitant

Zelzate's Grote Markt neighbourhood

- Lowest percentage of green
- Highest population density
- Lowest amount of cool area per inhabitant
- High percentage of elderly
- Low socio-economic score

Advanced heat stress vulnerability map

Grote Markt and Centrum Zelzate (BE)

User group: Visitors
Heat stress scenario: Rush hour

Zelzate: Grote Markt and Centrum

- Vital spatial typologies: city centre, shopping area and mobility hub
- Disconnected existing green infrastructure
- Social functions (post office, library)
- Schools (primary /middle/ high schools)

Which places call for urgent action?

- **Market area** under Level 2 Extreme Heat stress
- Double row of plane trees, when 10-15 meter tall have a 15-17 °C PET heat reduction capacity
- Aim to make the area car free

- **Bus station route** suffers from Level 2 Extreme Heat Stress
- Re-connecting existing green infrastructure: planting row of trees at the end of 2020 (maple, ornamental pear, rowan)

- **School yard**'s forested area offers escape from the heat, heat stress reduced to Moderate level
- Area's exposed to heat serve as Cool Towns pilot sites

Vulnerable spatial typologies

City centres / Shopping areas

Veemarktstraat, Breda, NL

Schools / Playgrounds

de Reigers School, Zelzate, BE

Residential neighbourhoods

Waverley Road, Margate, UK

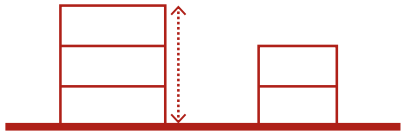
Mobility hubs

Bus station, Middelburg, NL

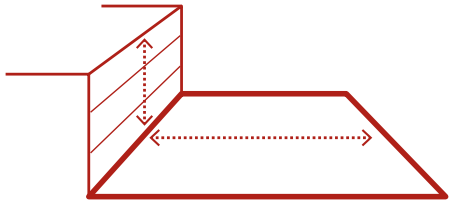
Pedestrian / Cycling routes

Coehoornstraat, Breda, NL

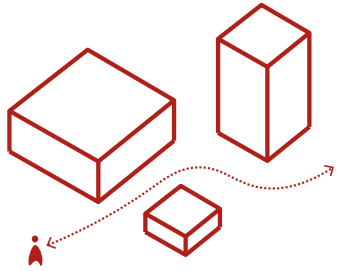
- Identifing vulnerabilities in and between outdoor spaces
- Resolving through tactical small-scale interventions as a start



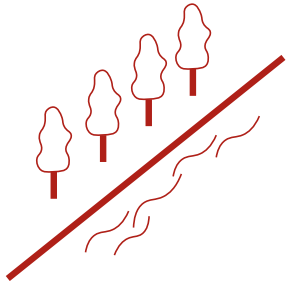
Urban Geometry



Height-Width Ratio



Social Movement



Greeb-blue infrastructure

User-groups

Street level solutions: Intervention Catalogue

Tree(s)

Single tree, Ghent (BE)

- single tree
- row of trees
- group of trees

Shelter Canopy

Shade sails, Amsterdam (NL)

- shade sail
- awning
- pergola

Green Wall

Indirect green facade, Ardooie (BE)

- direct green façade
- indirect green façade
- living wall system
- free-standing green screen

Water Feature

Fountain, Merelbeke (BE)

- fountain
- smaller waterway
- misting

Cool Surface

Vegetated paving, Merelbeke (BE)

- grass
- vegetated paving
- damped pavement

...but how effective are these heat stress mitigation interventions

Intervention effectiveness depends on many factors

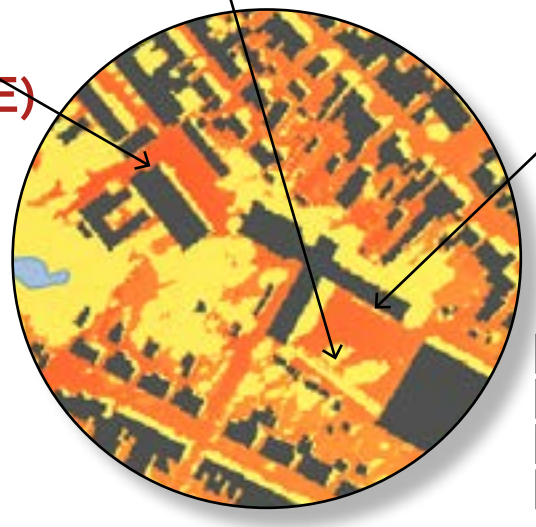
Cool Towns pilot: Awning

Single Hornbeam tree

Row of Catalpa trees

de Reigers primary school & Atheneum high school in Zelzate (BE)

- Mix of low and tall buildings
- Shaded woody areas vs. open yards exposed to heat
- Places to stay, play or move through



Rush hour scenario

- 29-35 Moderate Heat Stress
- 35-41 Strong Heat Stress
- 41-46 Extreme Heat Stress (LV1)
- 46-51 Extreme Heat Stress (LV2)

Street level solutions: Intervention Catalogue

Tree(s)

Single tree, Ghent (BE)

-3-19 PET °C

Shelter Canopy

Shade sails, Amsterdam (NL)

-11-21 PET °C

Green Wall

Indirect green facade, Ardooie (BE)

1-4 PET °C*

Water Feature

Fountain, Merelbeke (BE)

-0,5-2 PET °C

Cool Surface

Vegetated paving, Merelbeke (BE)

-PET °C

Cool Towns Intervention Catalogue & European Urban Heat Atlas

Publication in Autumn 2022

Invitation
Cool Towns
Final Conference
20 october 2022 in
Ostend

Contact Gideon Spanjar: g.spanjar@hva.nl
More information: cooltowns.eu