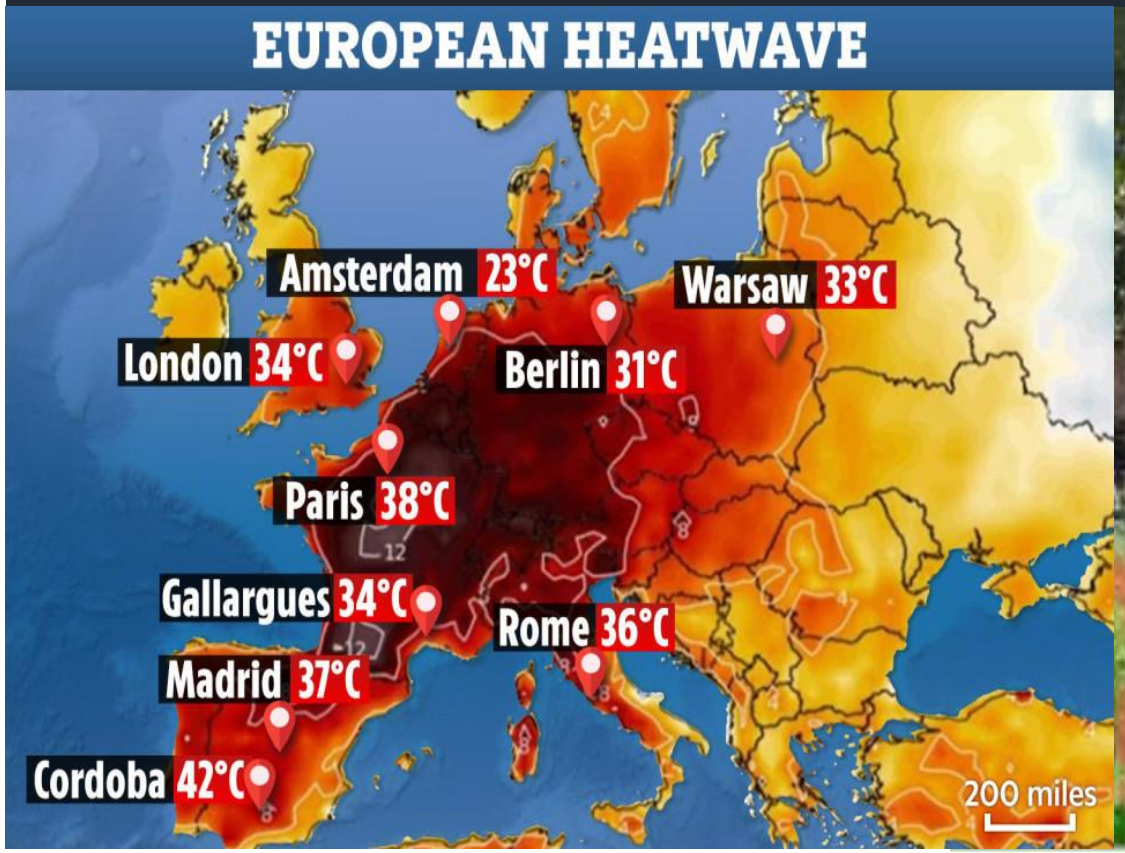
Urban heat mitigation and adaptation strategies against climate change effects



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Resilience against short term events

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Disruptions

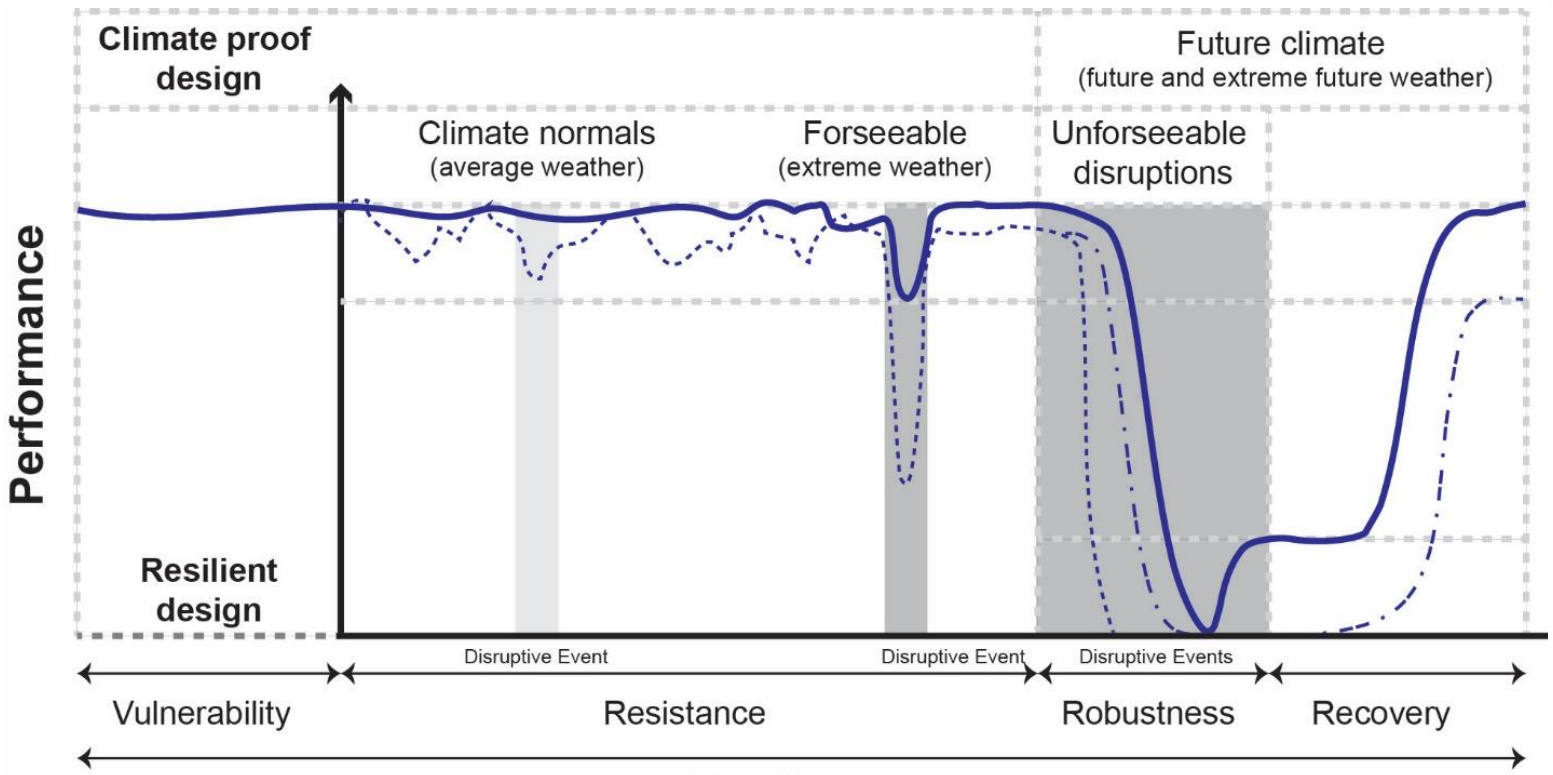
Drought

Floods

Heatwave

Fire

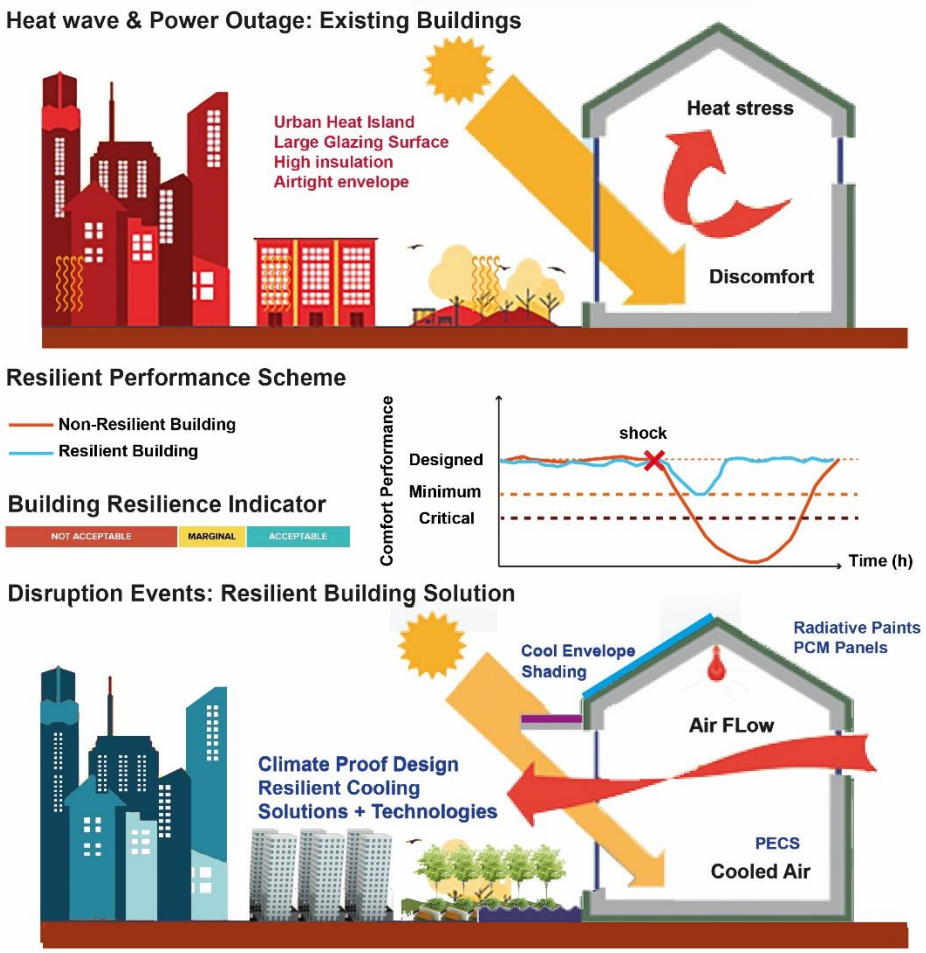
Definition: Resilience vs. Shock = FAILURE



1. designed thermal conditions
2. minimum thermal conditions
3. critical thermal conditions

1. weather files: extreme weather
2. weather files: average weather
3. weather files: future weather
4. weather files: worst future weather

Event 1: short extensive heatwave
Event 2: short intensive heatwave
Event 3: long extensive heatwave
Event 4: long intensive heatwave
Event 5: power outage



Non-Resilient and Resilient Performance Curve during heat waves and power outage events.

doi.org/10.1016/j.egypro.2016.06.218

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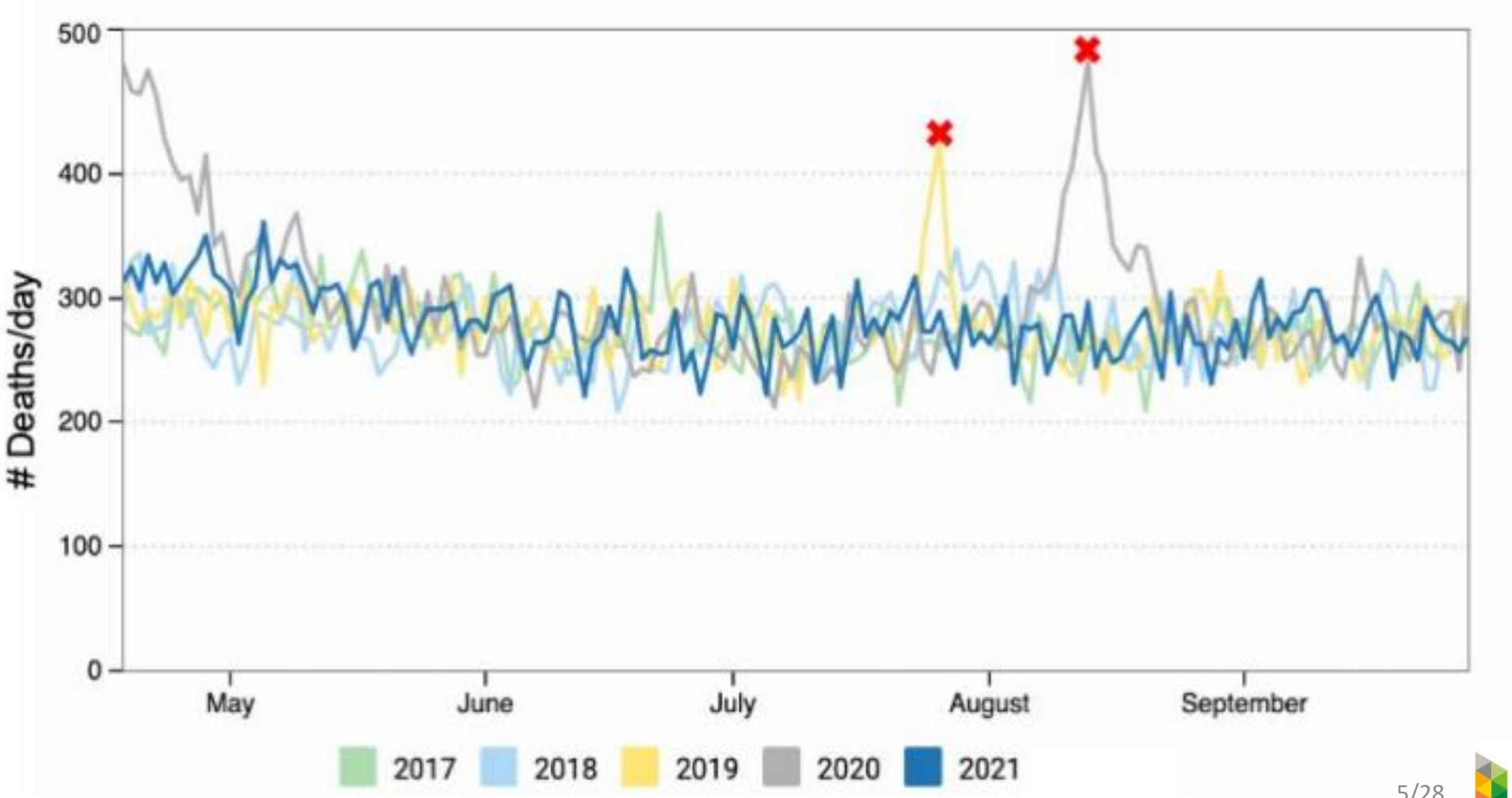
Mortality rates in Belgium 2017-2021

At least 15,000 people have died across Europe because of hot weather in 2022 (Germany 4500 - Belgium 1100)



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Heat Waves & Heat Island Effect

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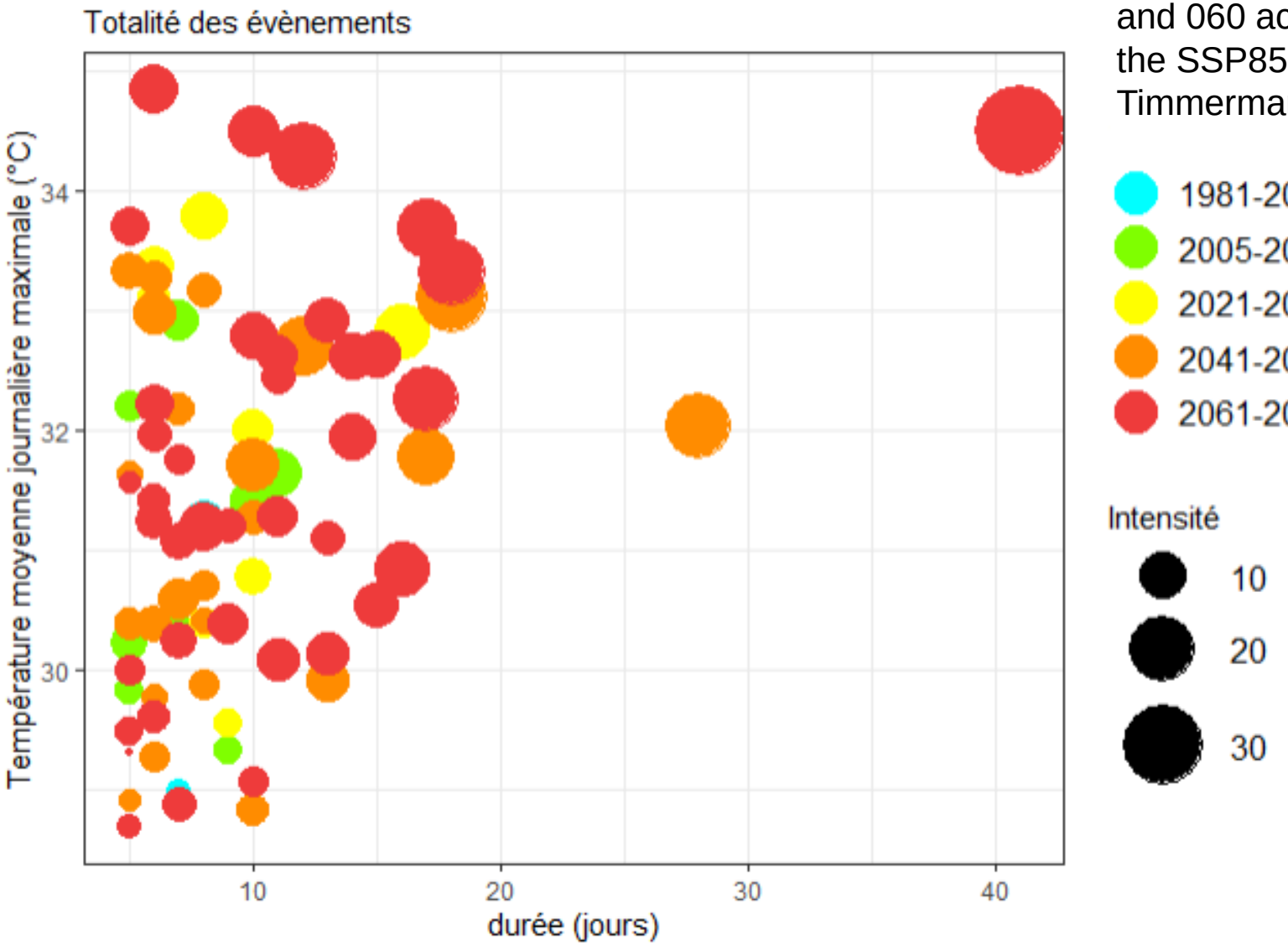
Heat Waves in Liège 1981-2080



Intensity of heat waves in Liege between 1981 and 060 according to MAR-MIR in the case of the SSP85 scenario. Source: Guillaume Timmermans 2022.

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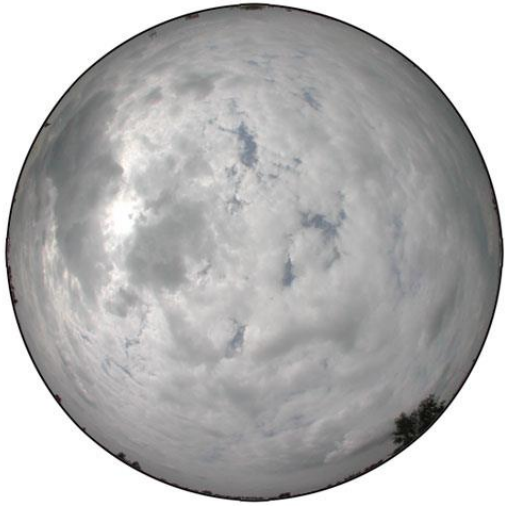
CIE Standardized Skies in Brussels



overcast sky

intermediate sky

clear sky

clear turbid / turbulent

Source: Wyard, C (2018). Global radiative flux and cloudiness variability for the Period 1959–2010 in Belgium: a comparison between reanalyses and the regional climate model MAR. Atmosphere, 9(7), 262.

Urban heat island effect

Enlarge the outdoor cooling period

Roofs and pavements cover about 60 percent of urban surfaces, and absorb more than 80 percent of the sunlight that contacts them. This energy is converted to heat, which results in hotter, more polluted cities, and higher energy costs.

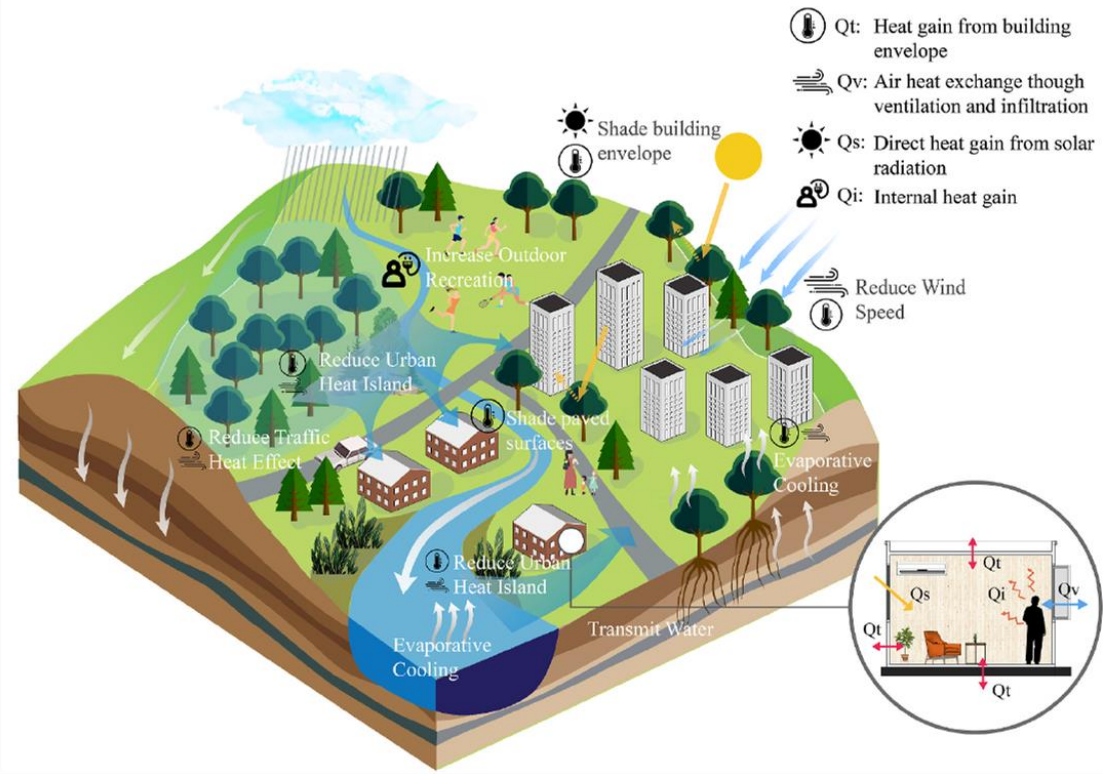


Fig. 4. Heat Island Effect Fluctuation On A Typical Urban Area

Fig. 5. The Summer Urban Heat Island Effect

http://www.coolrooftoolkit.org/wp-content/pdfs/CoolRoofToolkit_Full.pdf

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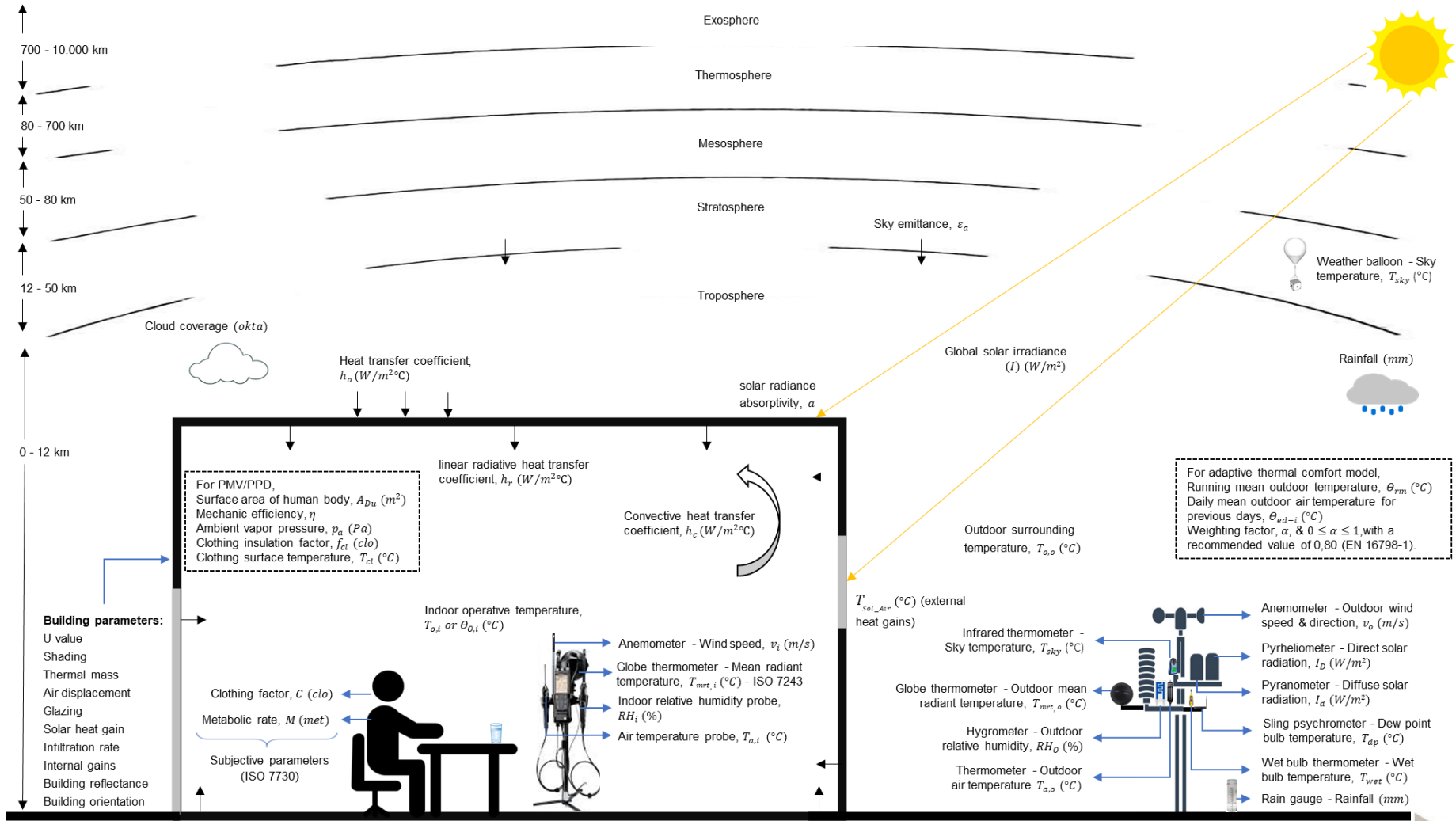
Outdoor & Indoor Comfort



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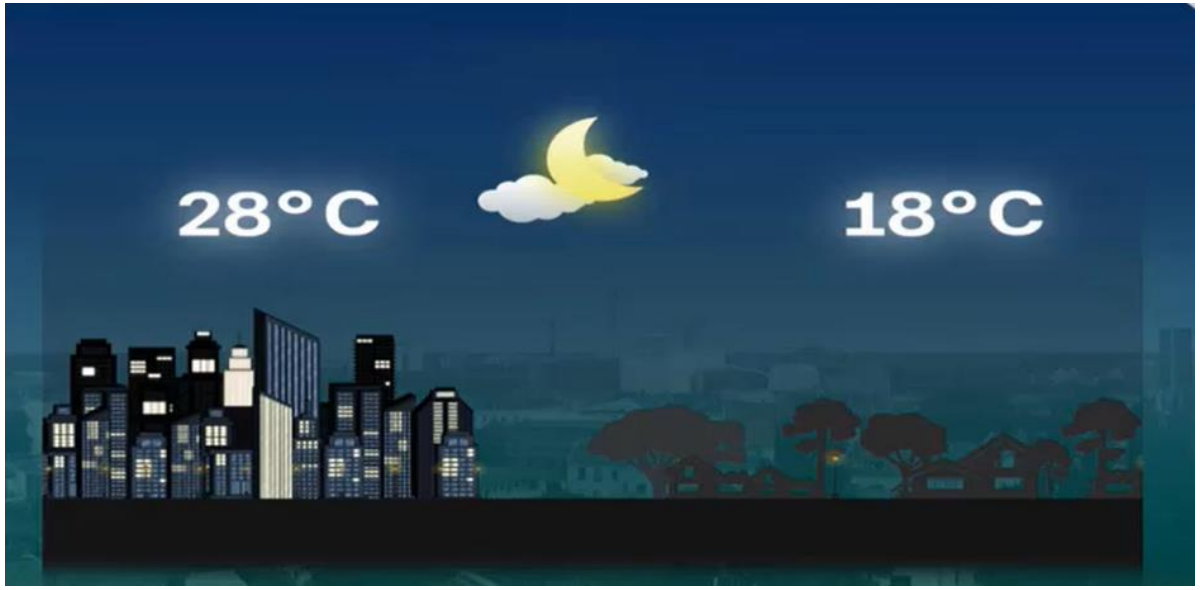
Tropical Nights in Brussels

Urban heating during the day and night is visible



Temperature variation between night and day

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Greenery KPIs for mitigation & adaptation to urban heat

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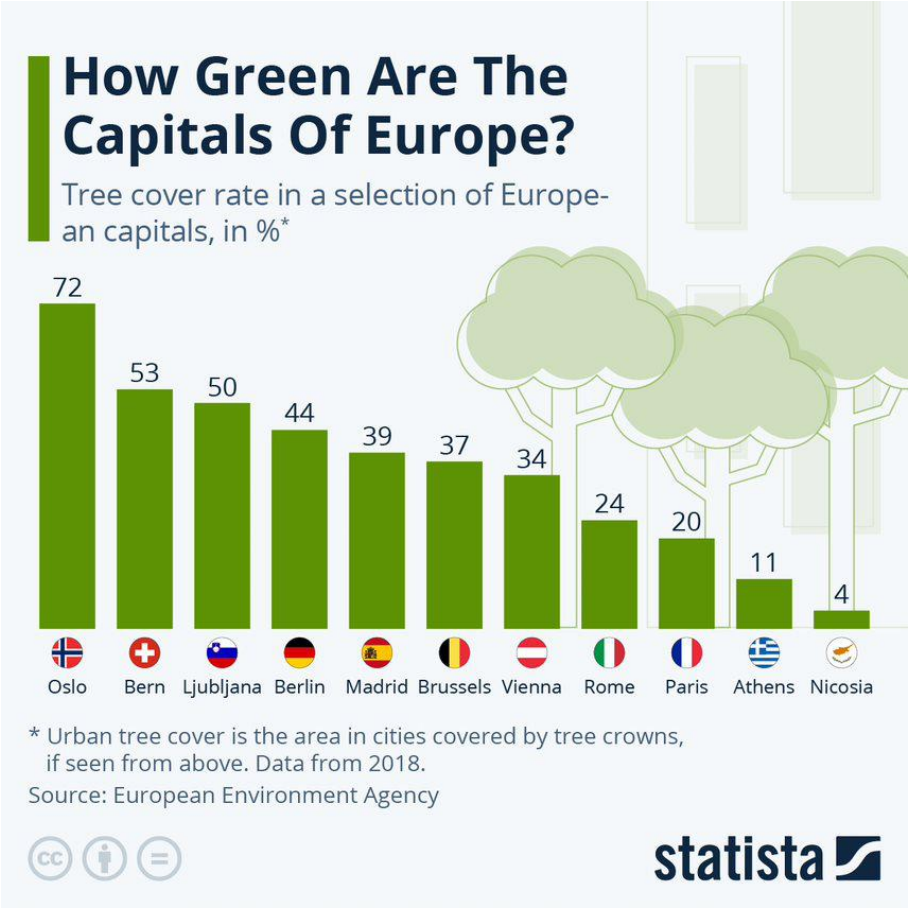
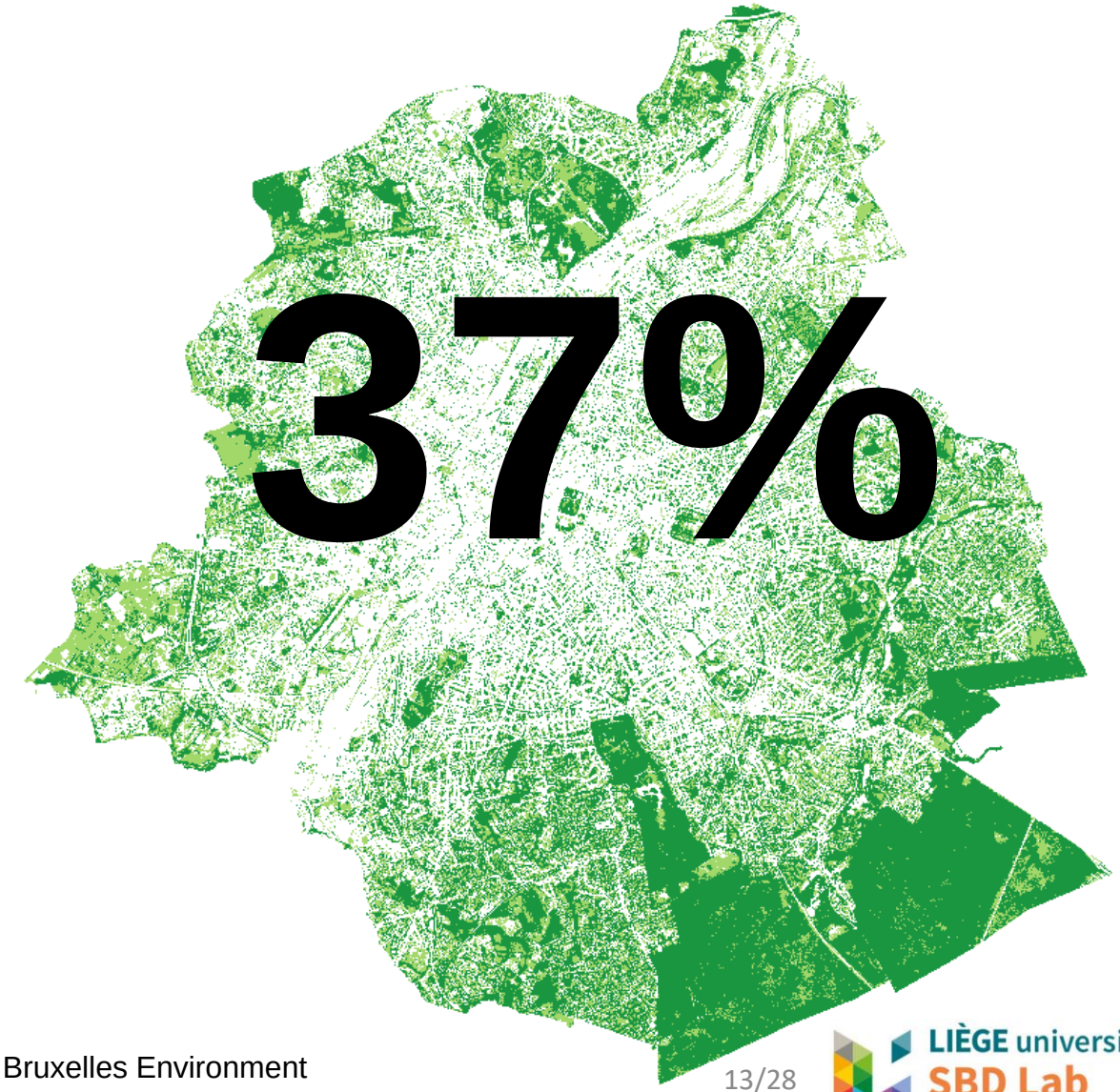
Key Performance Indicators

1. Tree Canopy Cover Indicator / 50% Target





Bruxelles Environment

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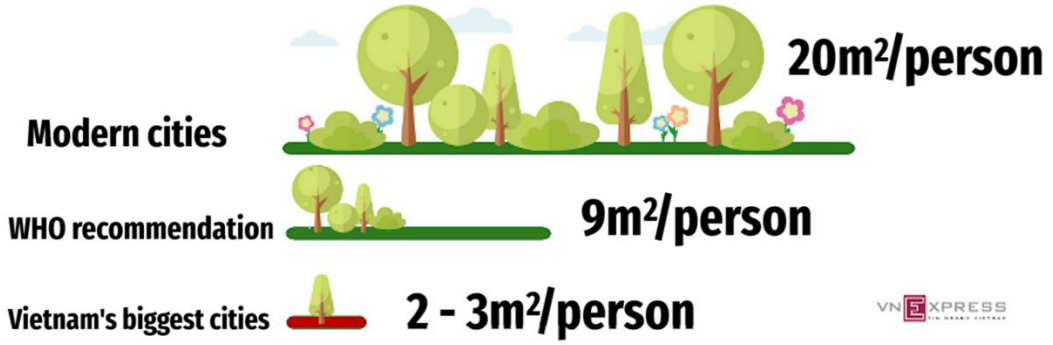
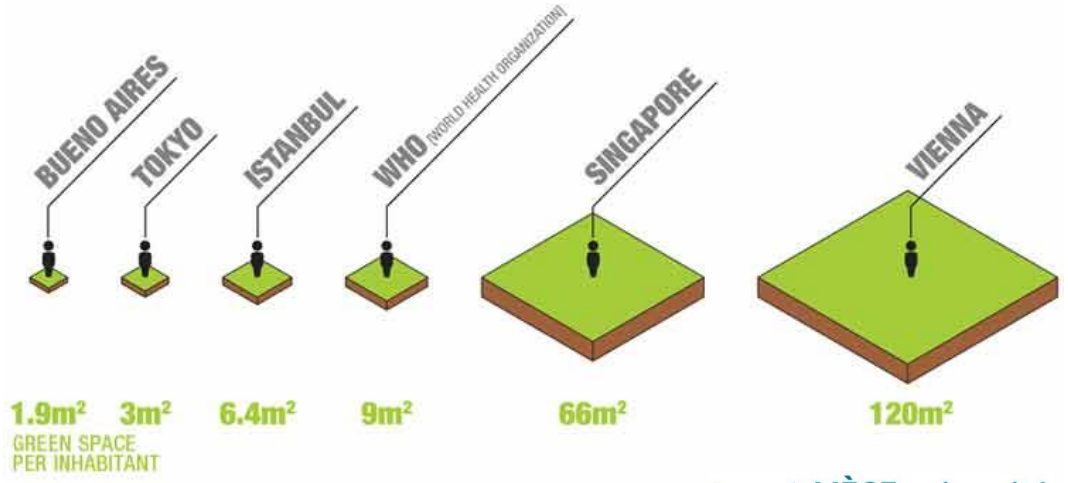
Key Performance Indicators

1. Tree Canopy Cover Indicator / 50% Target
2. 10-12 squared meter per citizen according WHO





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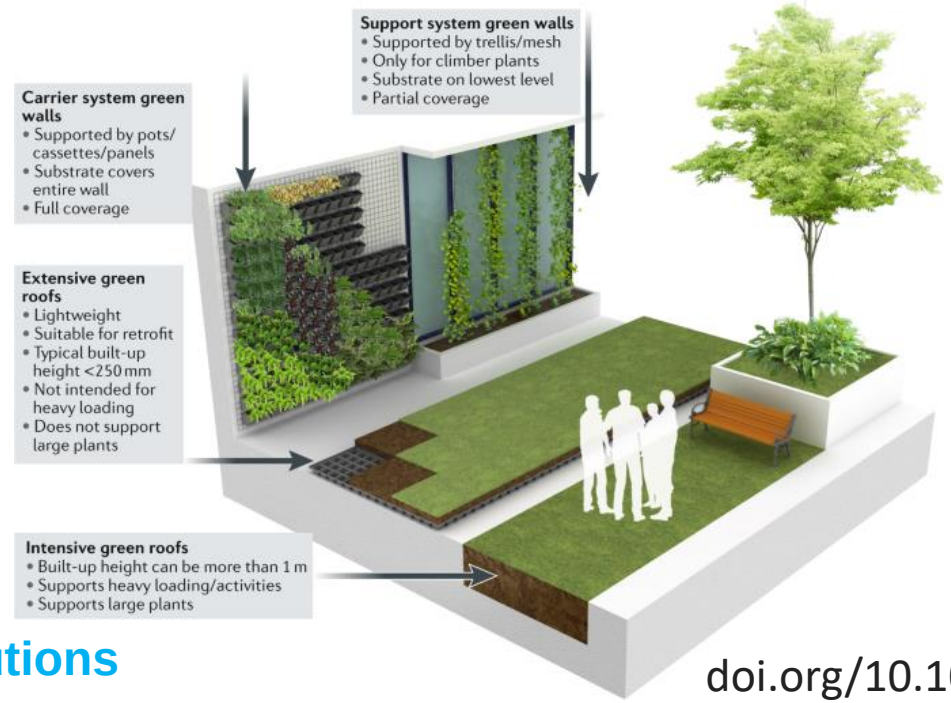
Key Performance Indicators

1. Tree Canopy Cover Indicator / 50% Target
2. 10-12 squared meter per citizen according WHO
3. Available Water Capacity, Soil Compaction and presence of Organic Matter
4. Biodiversity



Nature-based Solutions

doi.org/10.1038/s43017-020-00129-5

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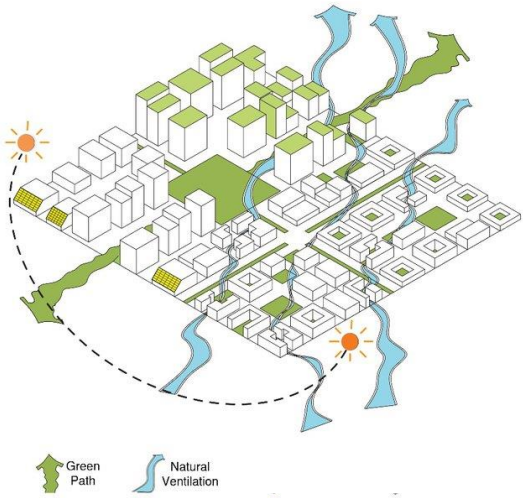
Key Performance Indicators

Green Corridors & Networks



Natural Ventilation

Vegetated Surfaces

Urban Trees

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Acupuncture Approach

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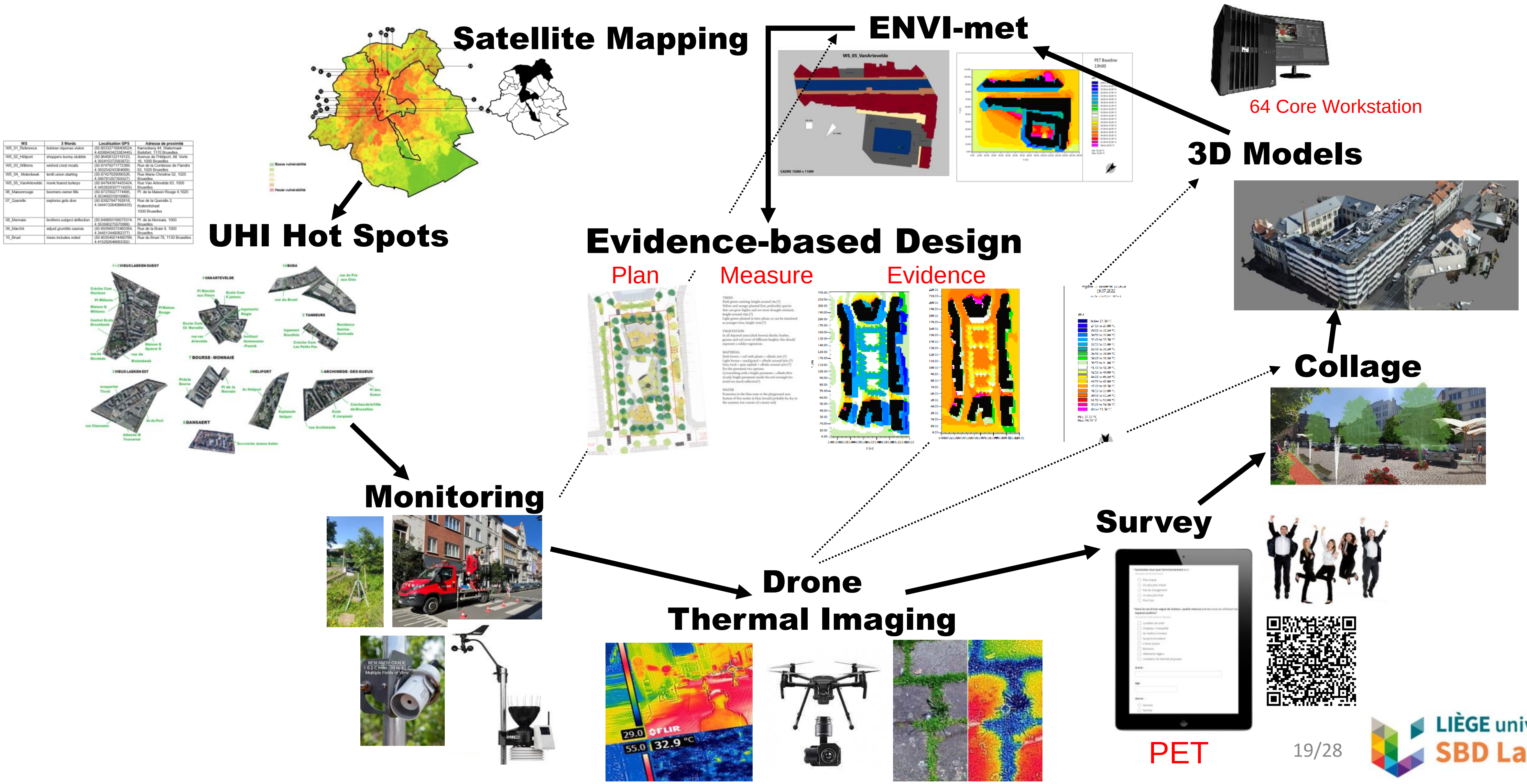
Acupuncture Approach



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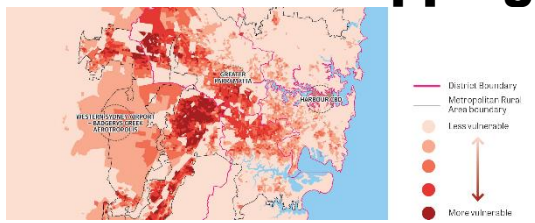
Digital Twin & AI based Irrigation Approach

Heatwaves Vulnerability Mapping



Parks Cool Island Effect

Sydney Olympic Park

Monitoring

50 Low-Cost Sensors

Weather Stations

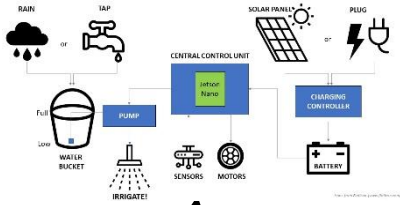
30 Weather Stations

Optimal Control Alg.

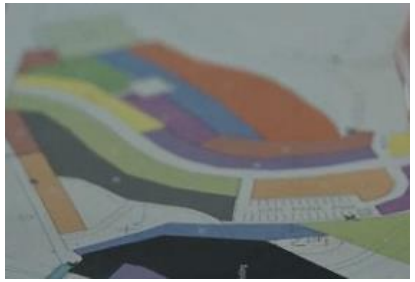
64 Core Workstation

Optimal Irrigation and Cooling

Algorithm Validation



AI Module for Irrigation



Digital Twin

Sources: Kineses 2016m 2022 Pfautsch: https://www.uts.edu.au/isf/explore-research/projects/new-south-wales-coolest-public-park

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Conclusions

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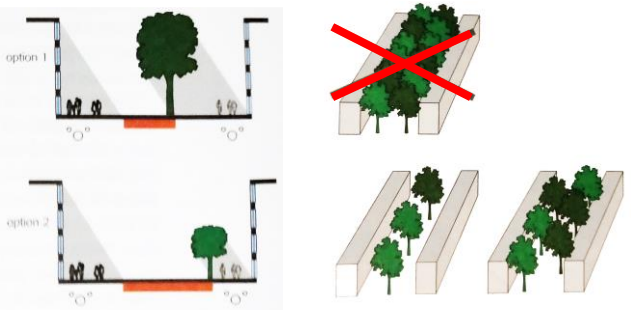
Conclusions



Simulations report the following measures ineffective:

1. **Green roofs & facades**
2. **Light colour roofs & facades**
3. **Narrow Streets**
4. **Dense street canopy**

This is working:

a) **Natural Ventilation in relation to urban morphology & urban trees**
b) **Vegetation of surface '*Tegelwippen*' '*Turn the tiles*'**
c) **Trees for Shading with advanced modeling**
d) **Artificial Irrigation with advanced monitoring**

Dimitri Strobbe

Samuel Van de Vijver

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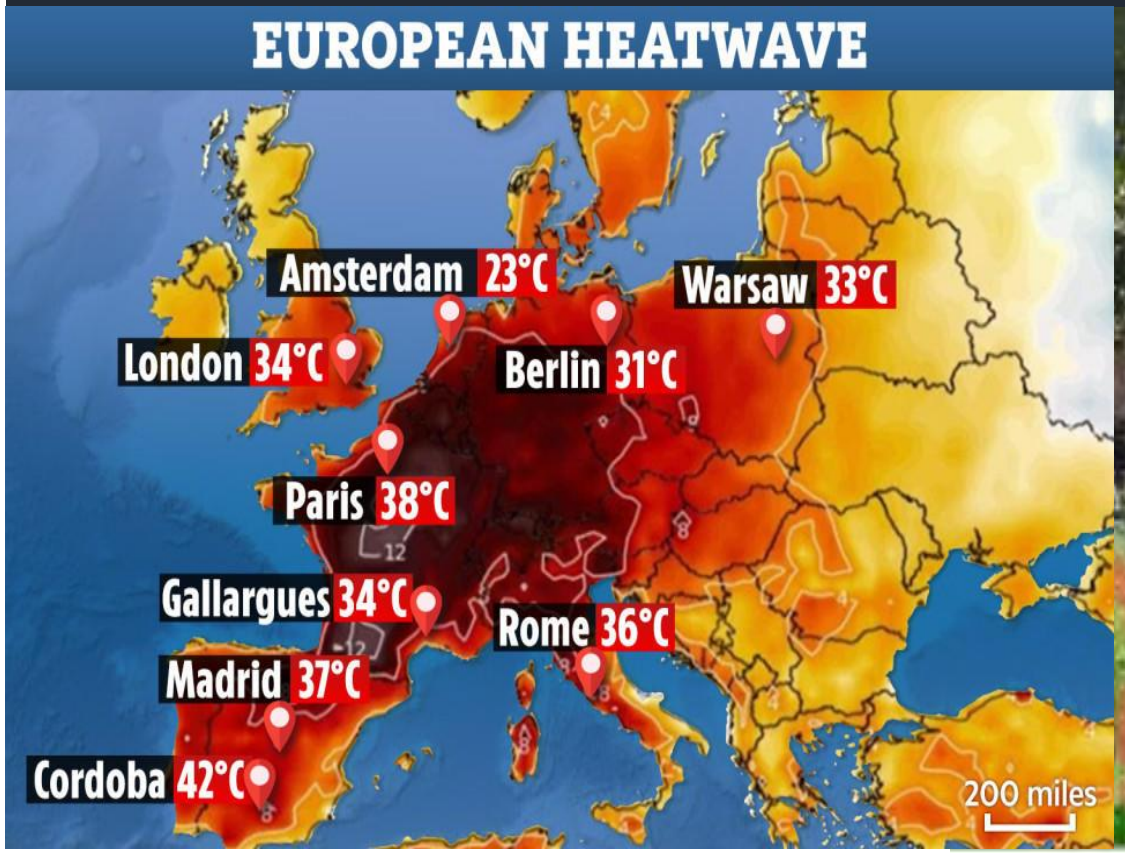

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