Heat stress in Swedish Cities and the Role of Urban Planning

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Motivation

The heatwaves have increased in duration, frequency and intensity over the years along with the global climate change, and will continue to do so!

The individual can be affected by the heat in the **short** and **long** term:

SHORT Nauseous, Exhausted, Heat stroke

LONG Dehydration can injure kidneys

Heat stress can have health risks for all individuals, especially for those in risk group!

The climate within the city differs from that in its outskirts, leading to a temperature gradient → Urban Heat Island (UHI)

The thesis can be found here!

Research Questions:

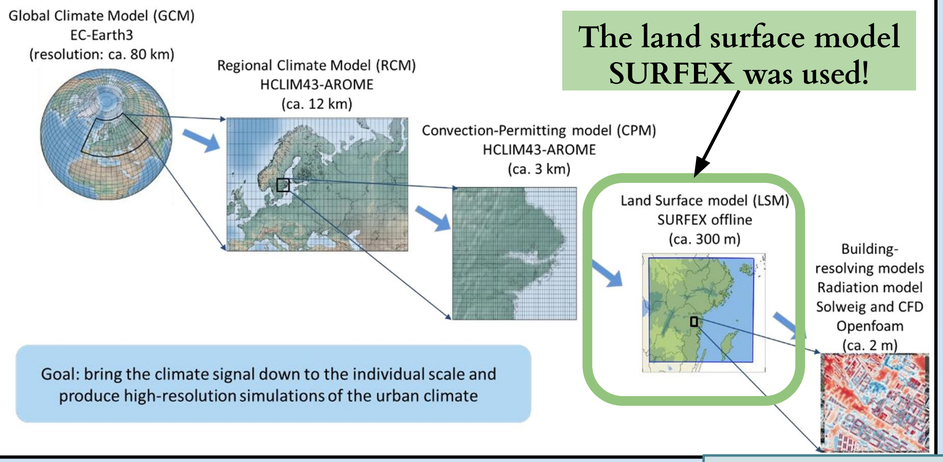
Focusing on the Swedish city of Stockholm, this study investigates the following research questions:

1. To which degree have different urban planning typologies (defined according to the LCZ classification) contributed the most to reduce the heat stress in the city?

2. How is the relationship between the LCZs and heat stress affected by different climate conditions, including heatwave events?

Methodology

Dynamical downscaling of the urban climate



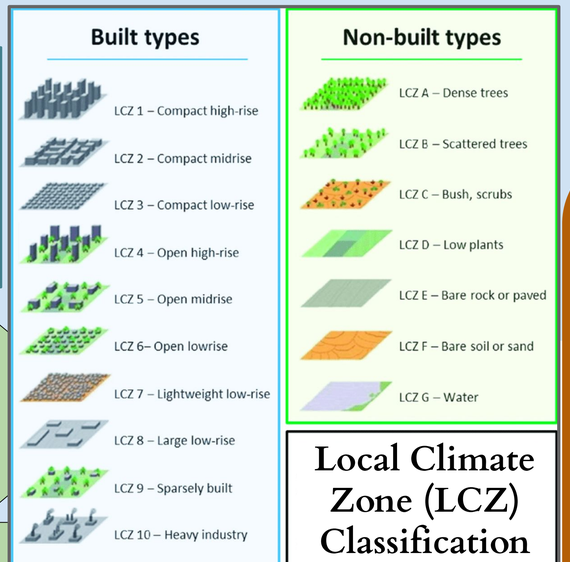
Five parameters were analysed:

1. **Air temperature at 2m** (°C)
2. **Relative humidity at 2m** (%)
3. **Wind at 10m** (m/s)
4. **Mean Radiant Temperature** (MRT, °C):
   "The result of radiation fluxes that the individual is affected by"
5. **Universal Thermal Climate Index** (UTCI, °C): A *heat index* that is formed by combining parameters 1-4. Its value represents how the individual perceives the heat with different consequences on the human body based on heat stress.

BOX 1

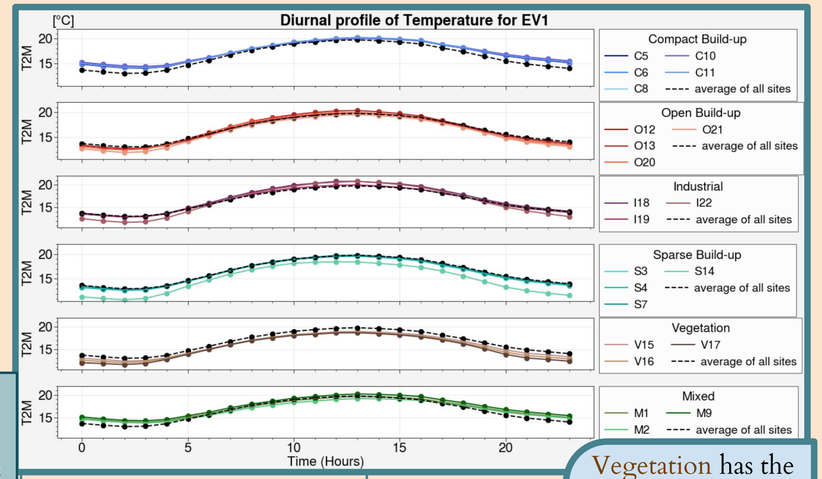
G1, Compact Build-up: LCZ 1-3
G2, Open Build-up: LCZ 4-6
G3, Industrial: LCZ 8, 10
G4, Sparse Build-up: LCZ 9
G5, Vegetation: LCZ A
G6, Mixed: LCZ 1, 9, G

Can micro-climates within a city affect the heat stress and the thermal comfort of the individual to different extents? The **Local Climate Zone (LCZ) Classification** can be used to understand this!



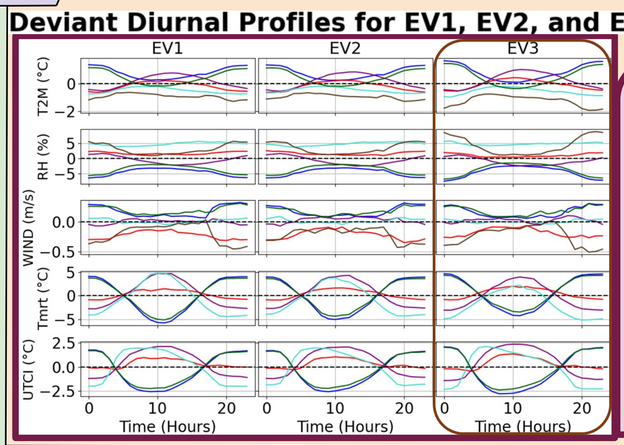
Local Climate Zone (LCZ) Classification

What was found from the study?



See **BOX 1** for LCZ-groups reference!

"Normal summer"



The largest deviations were found for Compact Build-up and Mixed during EV3. Studies have shown how UHI is intensified during more extreme conditions, which could be an explanation for this.

Vegetation has the lowest temperatures due to its cooling evaporative mechanism, and shading providing a mitigating effect. Compact Build-up provides shading during the day, decreasing the heat stress. It has the highest night temperatures due to the heat from the day being released.

Event-based approach

To understand how the LCZs are affected in different climate conditions, three representative summers (events, EV) are selected:

- **The summer of 2017** - a *normal* Swedish summer (EV1)
- **The summer of 2022** - a hot summer (EV2) → up to 2°C higher than the normal
- **The summer of 2018** - an extreme hot summer (EV3) → up to 4°C higher than the normal

Take home message

- Shading from vegetation and buildings had a mitigating effect during the day where buildings are densely constructed, while the latter contributed to a warming effect during the night.
- The heat stress is higher for densely built areas during extreme climate conditions, such as the summer of 2018.

In order to reduce the heat stress in cities, municipalities need to take the role of micro-climates into consideration in urban planning.