

Superblocks in Barcelona

EPFL



Exemple, Barcelona

Applied Geography 2025 Barcelona Superblocks

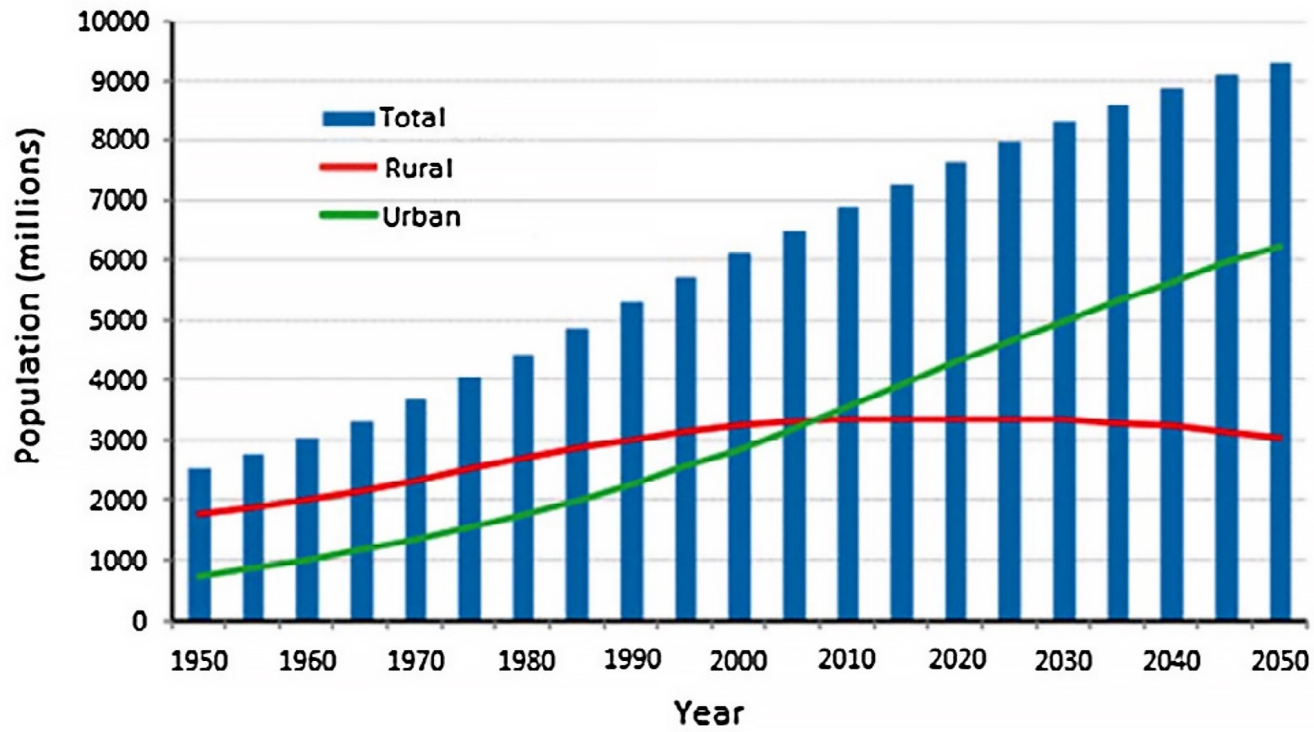
- **Context:** Urban heat islands
- **Case study:** Eixample in Barcelona
- **Ecological principle:** Vegetation cooling
- **Potential solution:** Superblocks and Green Axes

Context: Urban heat islands

EPFL

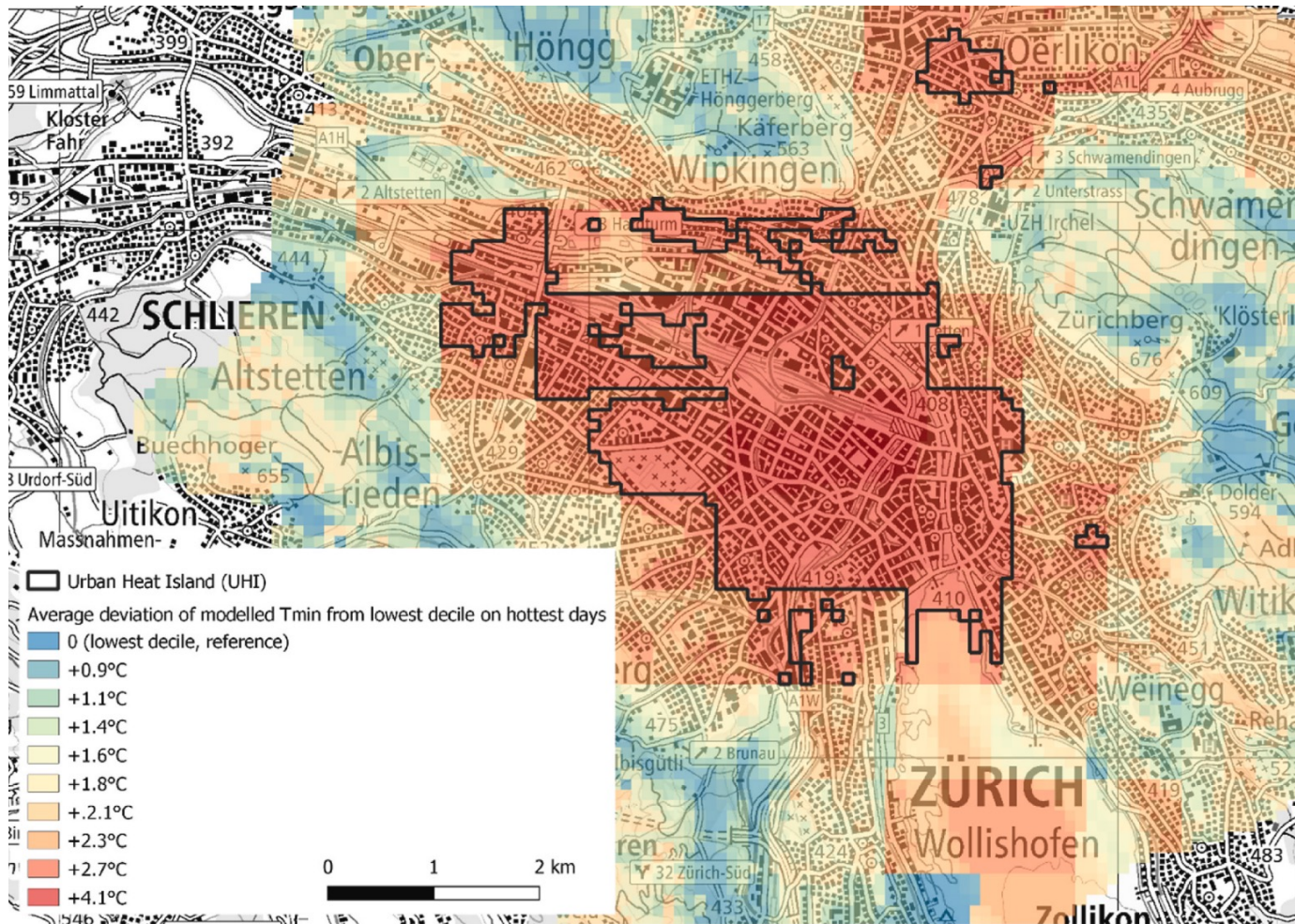


Global urbanisation



UN World Urbanisation Prospects 2014

The urban heat island



"In 2018, only 15 stations out of 576 were located in inner cities"

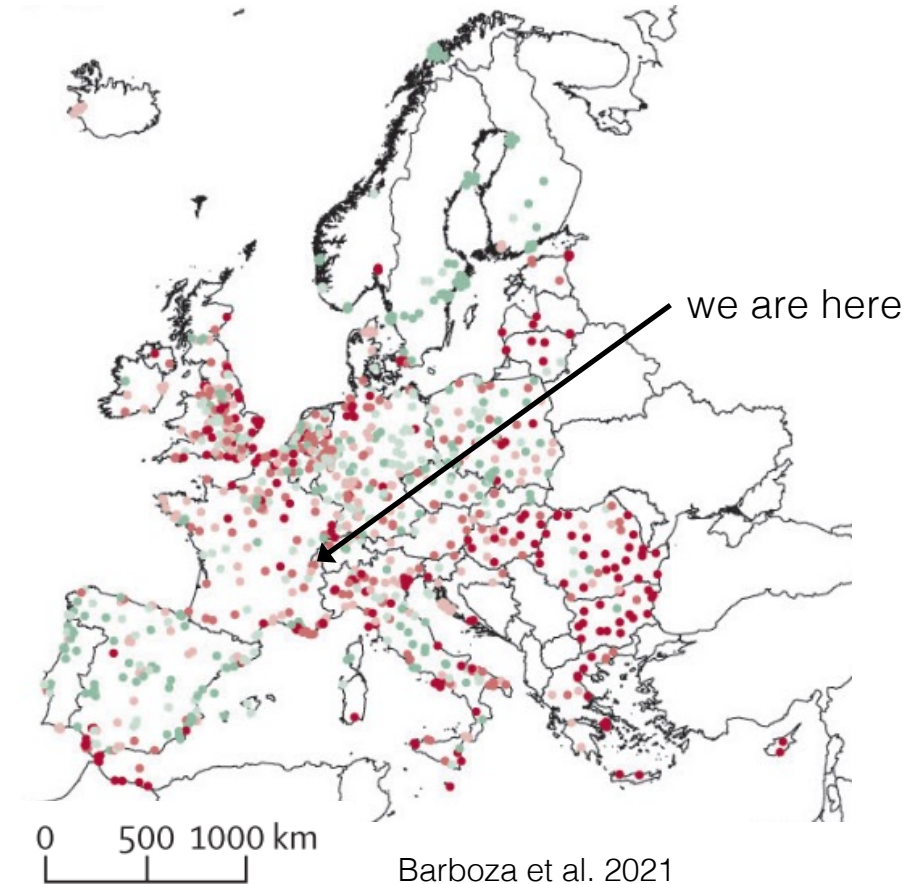
Wicki *et al.* 2024
Flückiger *et al.* 2022

Heat-induced deaths

- 2003 heat wave in Europe lead to more than 70'000 additional deaths
- Big cities were especially affected
- Access to green space could prevent 42'968 deaths annually
- Athens, Brussels, Budapest, Copenhagen, and Riga showed the highest mortality burdens due to the lack of green space

Percentage of green area ranking by quintiles

- 1 (highest mortality burden)
- 2
- 3
- 4
- 5 (lowest mortality burden)



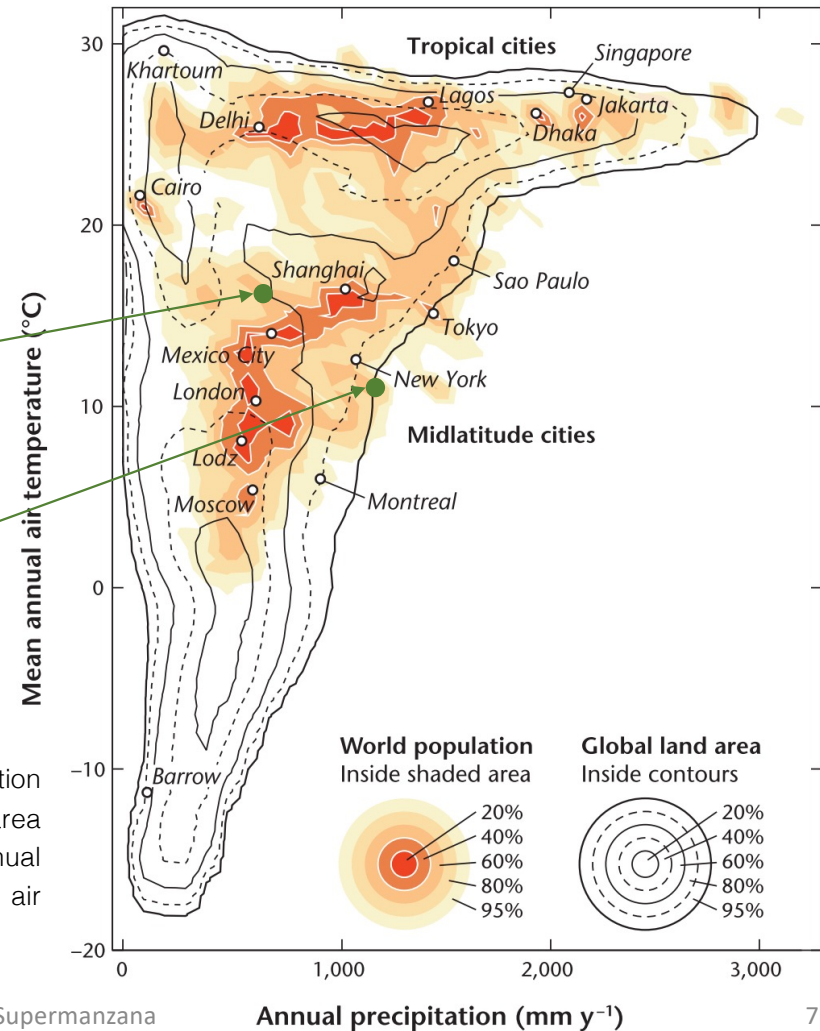
Where are the cities built?

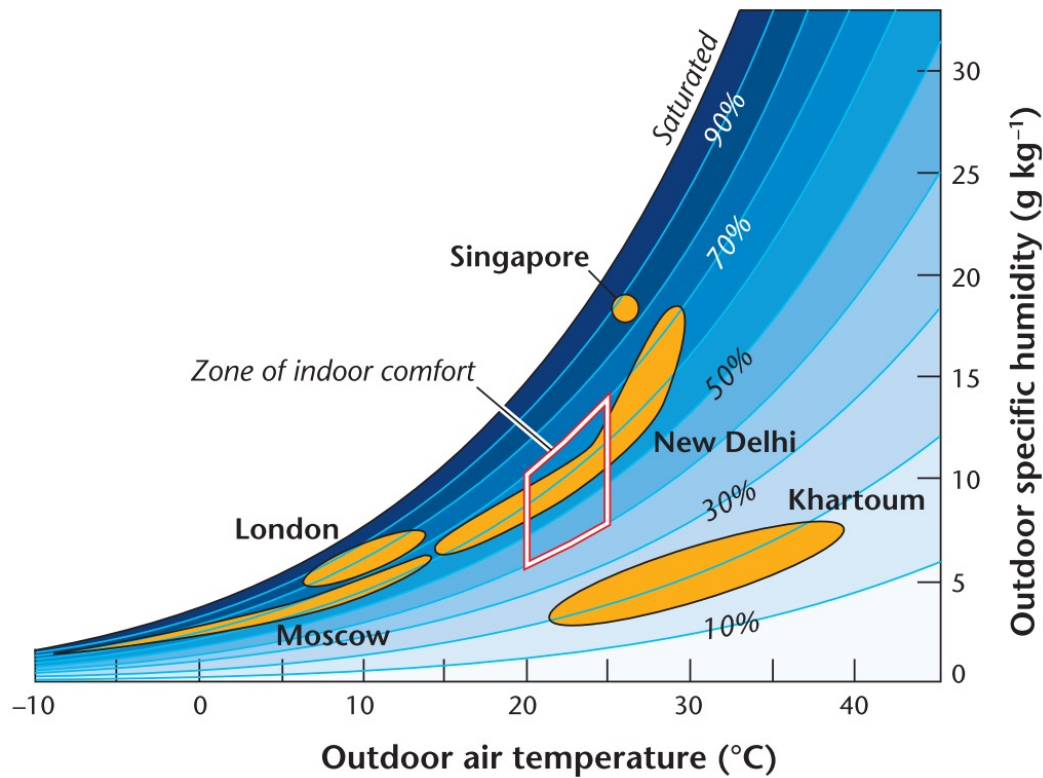
Cities are built in warm ($> 0\text{ }^{\circ}\text{C}$) and moist ($> 300\text{ mm}$) places with a few exceptions (e.g. Kairo and Khartoum $< 300\text{ mm}$ rain)

Barcelona (MAT $17.7\text{ }^{\circ}\text{C}$, MAP 658 mm)

Pully meteo swiss station (MAT $11.3\text{ }^{\circ}\text{C}$, MAP 1132 mm)

Figure 12.4 Map of global population distribution (shaded) and distribution of global land area (contours) in the parameter space of annual precipitation in mm yr^{-1} and annual mean air temperature in $^{\circ}\text{C}$. (Oke et al. 2017)



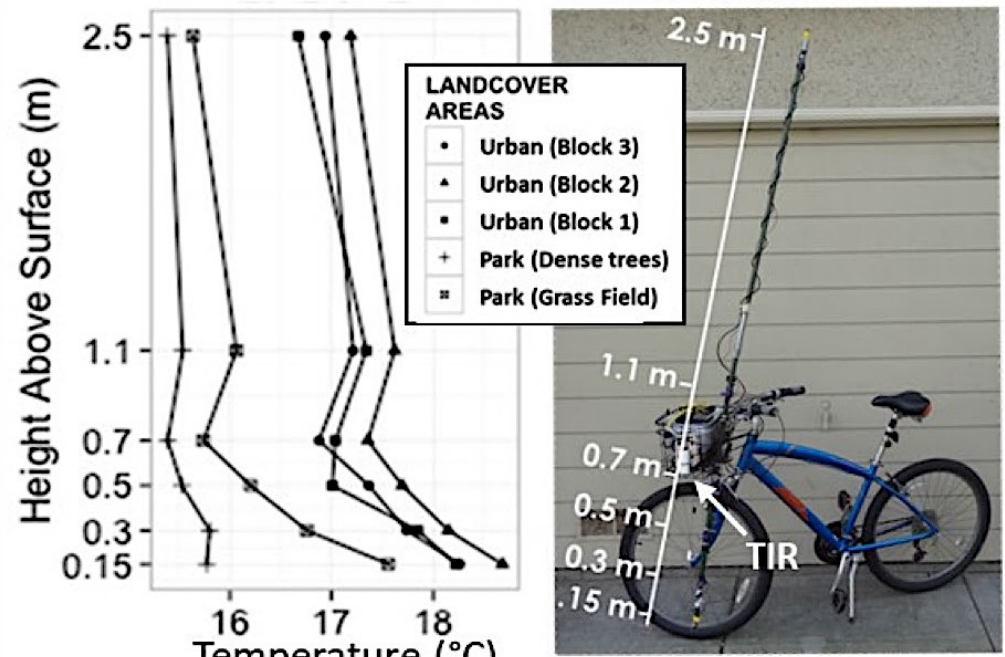
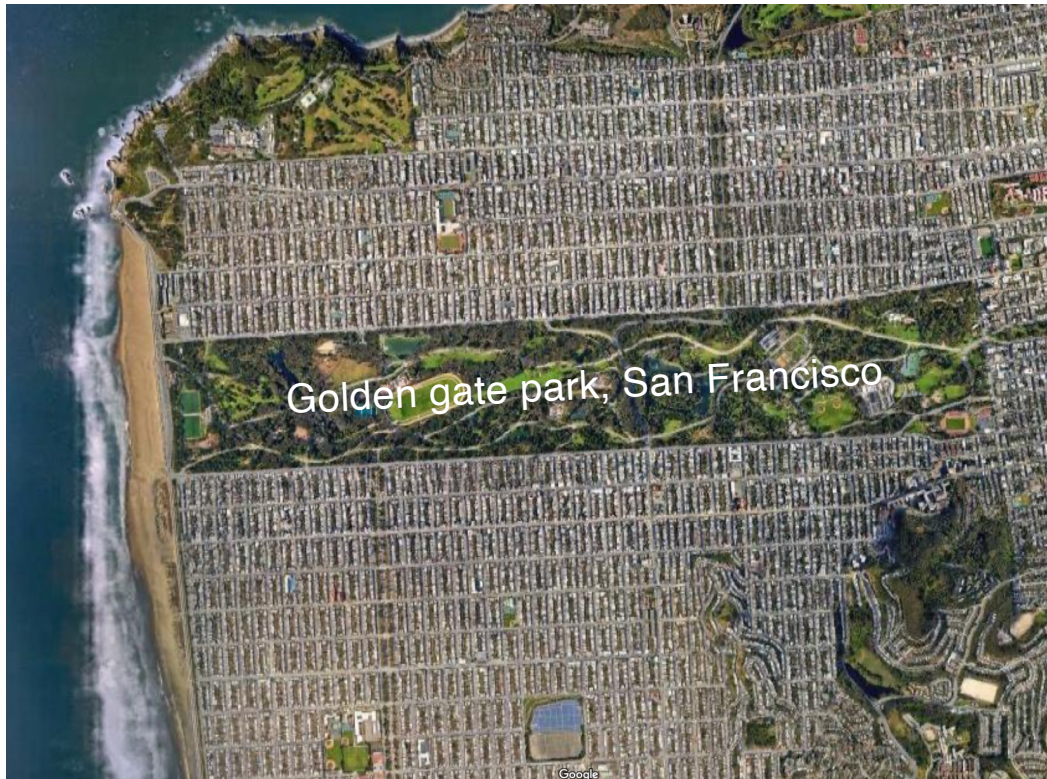


Distinct climate types give rise to different heating and cooling and (de)humidification needs.

- Singapore is wet and humid throughout the year
- London and Moscow are cool
- Khartoum (Sudan) is warm and dry
- New Delhi is warm at one time of the year and cool at another.

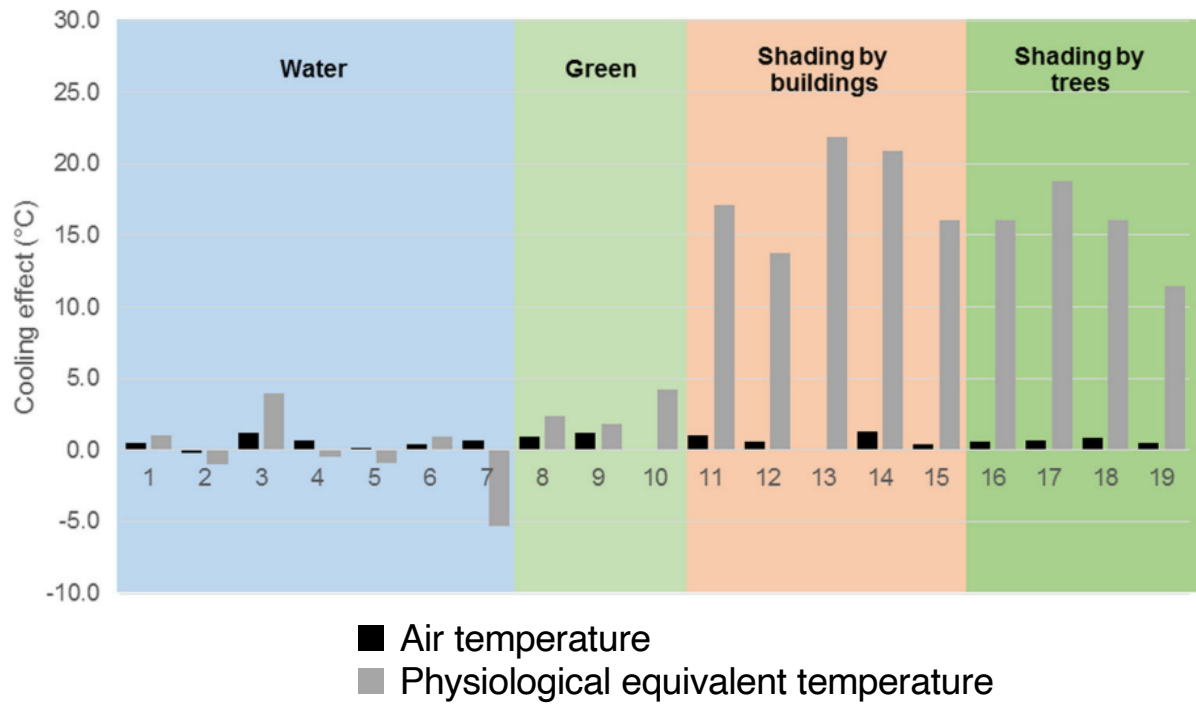
Figure 15.4 The climates of selected cities expressed in terms of the monthly air temperature and humidity. The area in the centre of the diagram represents a zone of indoor comfort that might be a desirable objective. (Oke et al. 2017)

What is urban heat?



Olifant et al. 2023 AGU

Air temperature vs. heat stress



Amsterdam, Klok et al. 2019

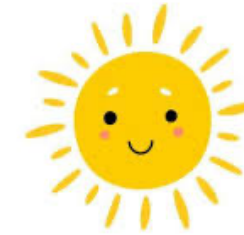


Heat stress: physiological equivalent temperature (PET)

Wind speed



Relative humidity



Solar radiation

Heat Balancing (MEMI): Summer

$T_a = 30\text{ °C}$, $T_{mrt} = 60\text{ °C}$, $RH = 50\%$, $v = 1.0\text{ m/s}$, $PET = 43\text{ °C}$

Internal heat production = 258 W

Mean skin temperature = 36.1 °C

Body core temperature = 37.5 °C

Skin wittedness: 53%

Water loss: 525 g/h



Respiratory heat loss = -27 W

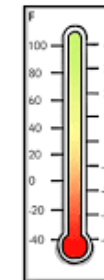
Imperceptible perspiration = -11 W

Sweat evaporation = -317 W

Convection = -143 W

Net radiation = +240 W

Body Parameters: 1.80 m, 75 kg, 35 years, 0.5 clo, walking (4 km/h)



Air temperature

Höppe et al. 1999

Urban heat island mitigation



16.09.25

"îlots de fraîcheur" in Paris, 2018

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"Plan canopé"

 Ville de Lausanne
Service des parcs
et domaines



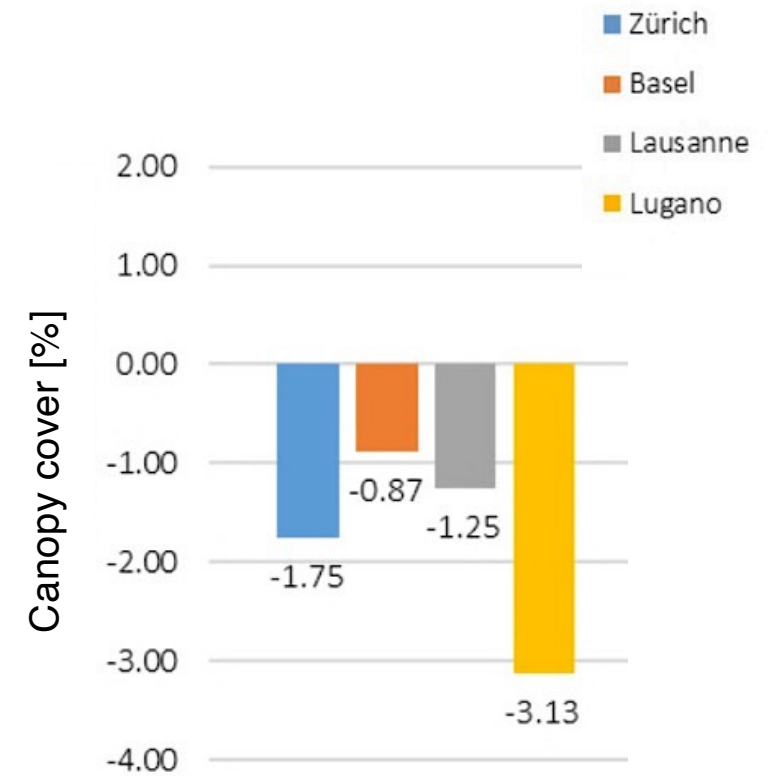
Ecoquartier
"Plaines-du-loup"

Plan vs. reality

Change in canopy coverage in swiss cities 2008 to 2018



Abbildung 21: Dokumentation einer Baumfällung in Lausanne, Standort: 46°32'27.53"N 6°37'54.80"E (Quelle: Google Earth).



Case study: Eixample in Barcelona



Human and tree populations in Barcelona

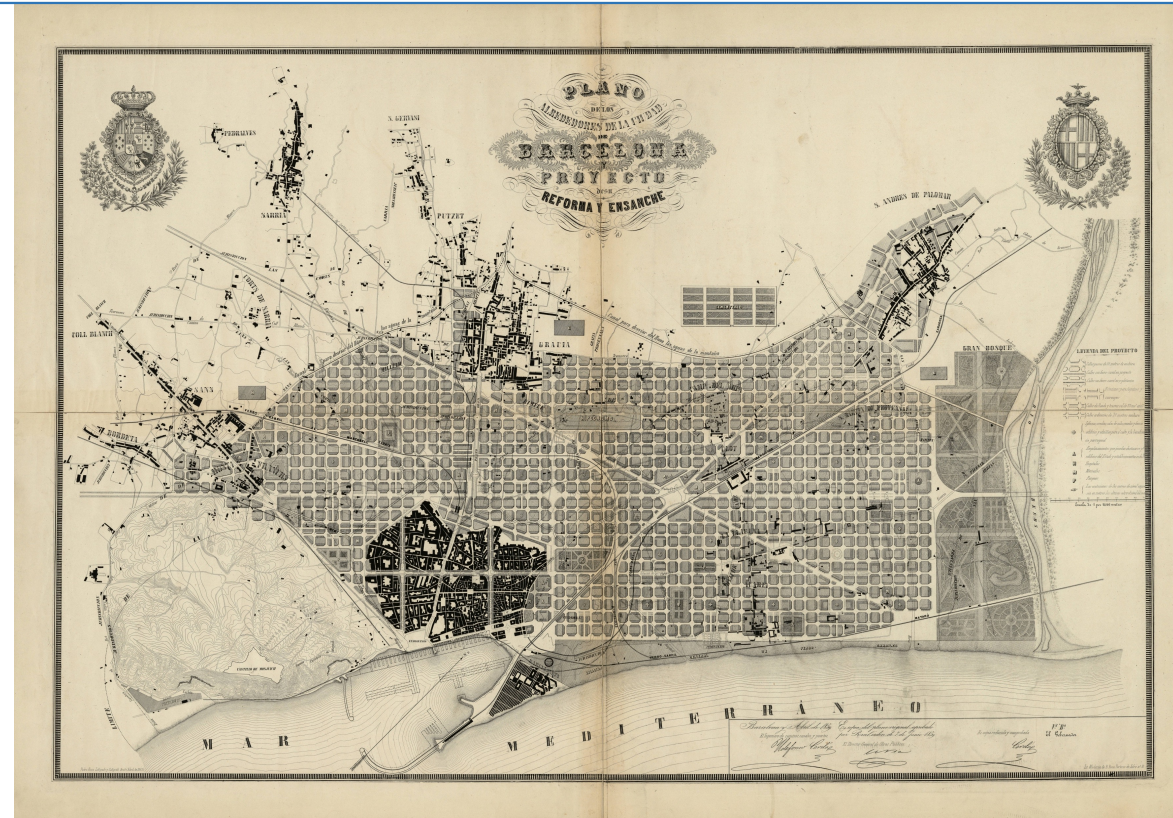
- 1.6 million people on 100 km²
- 1.4 million trees (152'128 street trees inventorised)
- One of the most densely populated places in Europe (35'800 inhabitants km⁻²)
- Little available space for green and public open space
- Temperature in the city center can be up to 8 °C higher in comparison with less urbanized surrounding areas because of the urban heat island (UHI)



Example, Barcelona

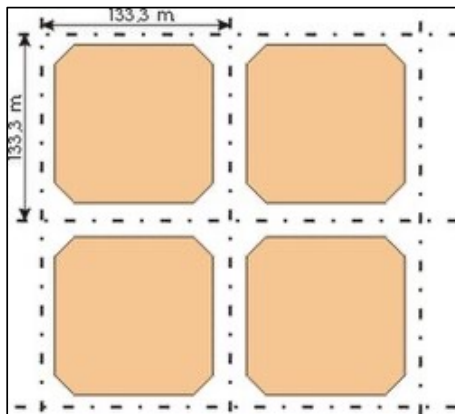
Barcelona in the 19th Century: health crisis

- Barcelona's population increased from 104'000 to 187'000 in 1798–1850
- The city remained confined within its old city walls, just 2 km² (today's Gothic Quarter)
- Population density: 93'000 inhabitants per km² (three times that of Paris)
- No clean water and sewers
- Devastating outbreaks killing over 10% of the population: yellow fever (1821) and cholera (1834 and 1854)

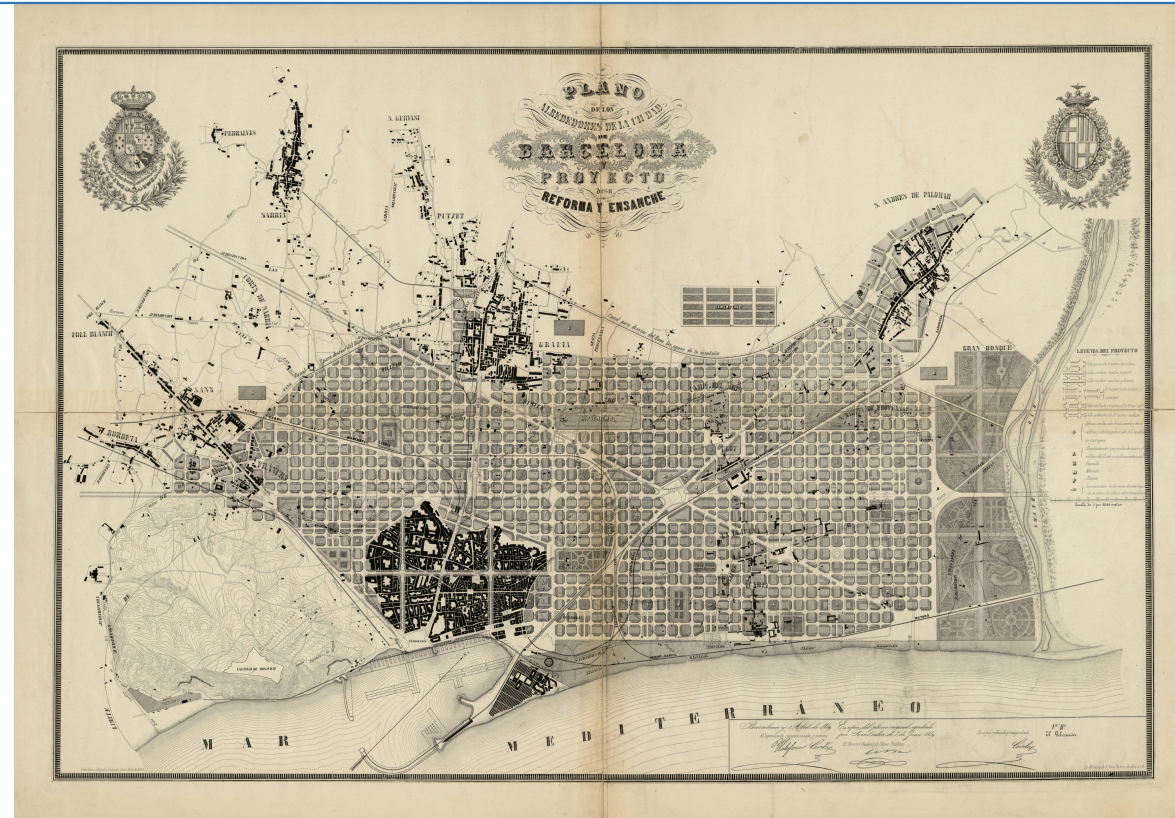


New urban plan: construct Eixample

After failed local proposals, the government in Madrid approved the plan to build "Eixample", despite opposition from Barcelona

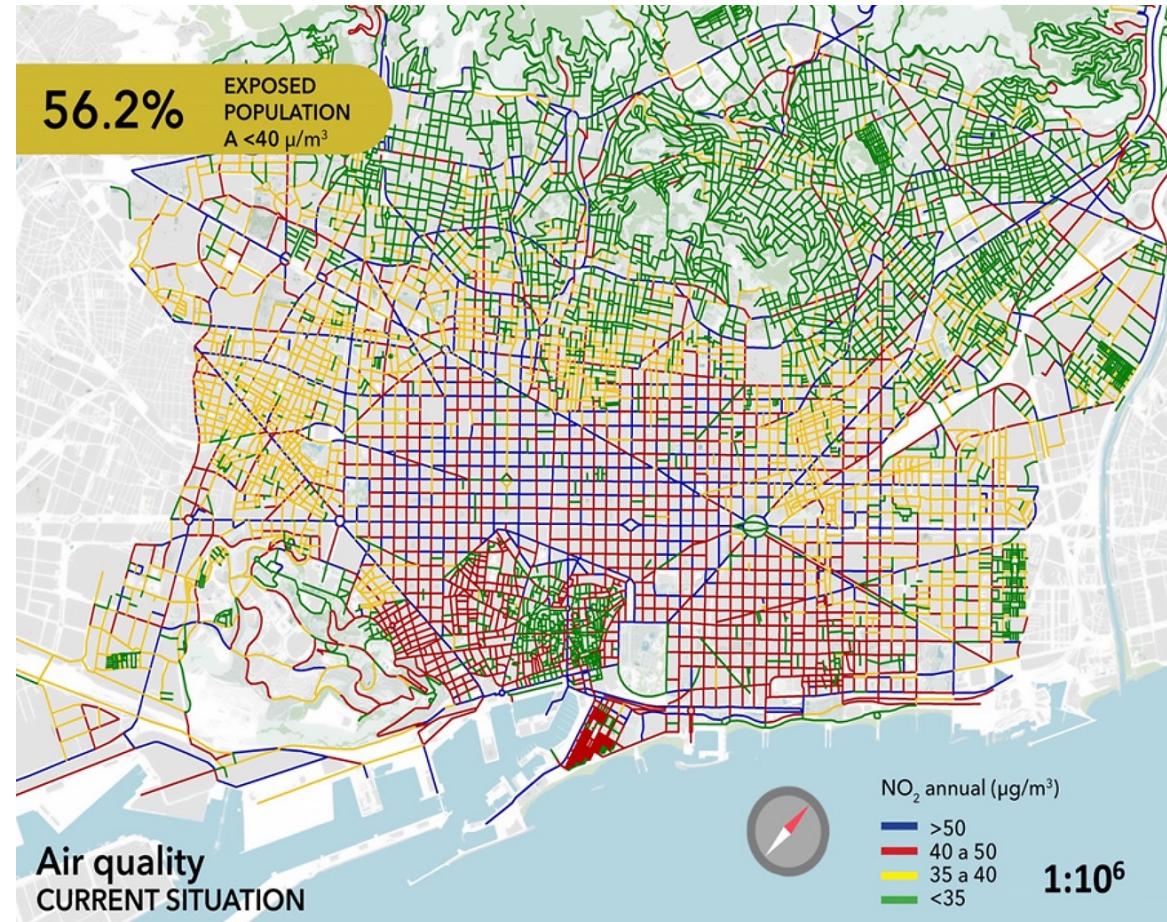


Block concept of Eixample



Barcelona Eixample

- District with the highest levels of air and noise pollution in Barcelona
- Worst deficit of green areas, with only 2 m² of green space per inhabitant
- Streets where vehicles occupy 60% of the surface, but they represent only 20% of users.



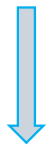
Lopez et al. 2020, Atmosphere

Ecological principle: Vegetation cooling

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Cool Pavings

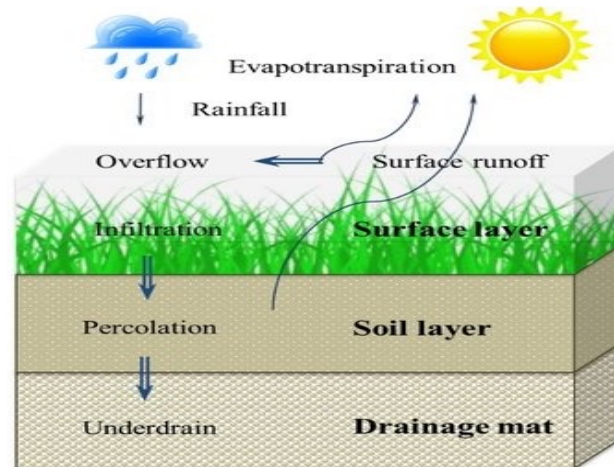
Increase Albedo
(reduce absorbed radiation)



<https://www.archdaily.com/>

Green Roofs

Increase Evapotranspiration
(reduce sensible heat flux Q_H)

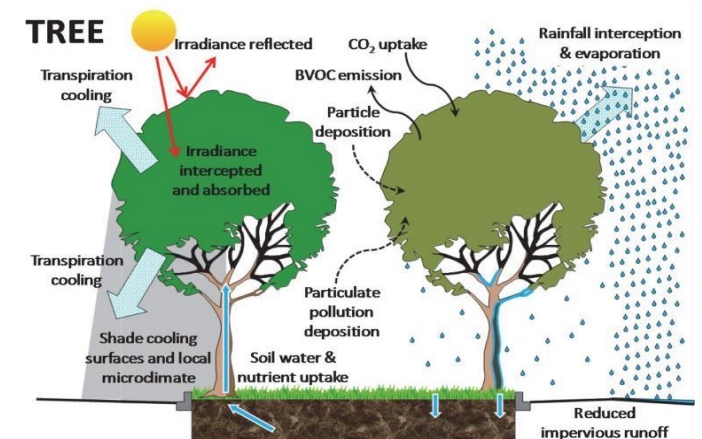


Liu and Chui, 2019

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Street Trees

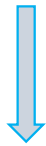
Shading + Evapotranspiration
(both benefits)



Livesley et al., 2016

Cool Pavings

Increase Albedo
(reduce absorbed radiation)

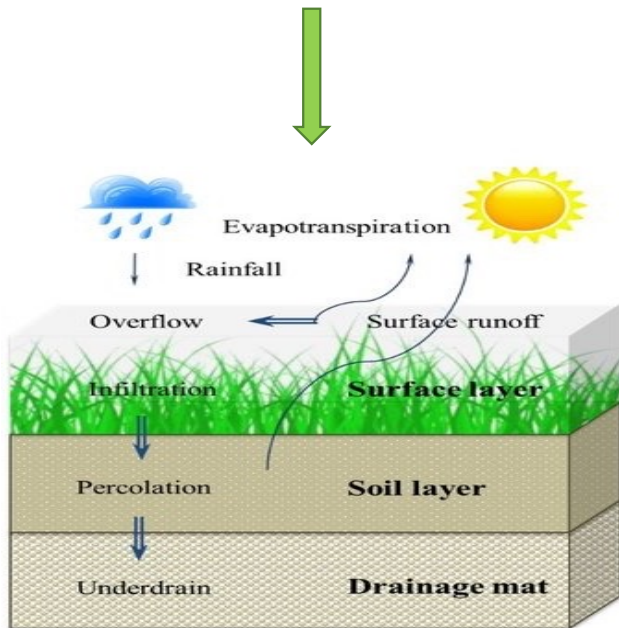


Limitations

- Require constant maintenance
- Impacts have limited spatial extent:
 - Roofs: no impacts on pedestrian level
 - Roads: limited impacts on sidewalks
- Cool roads can
 - be dangerously blinding to car drivers
 - Increase reflected shortwave radiation
- Cool roofs can increase wintertime building energy consumption

Green Roofs

Increase Evapotranspiration
(reduce sensible heat flux Q_H)

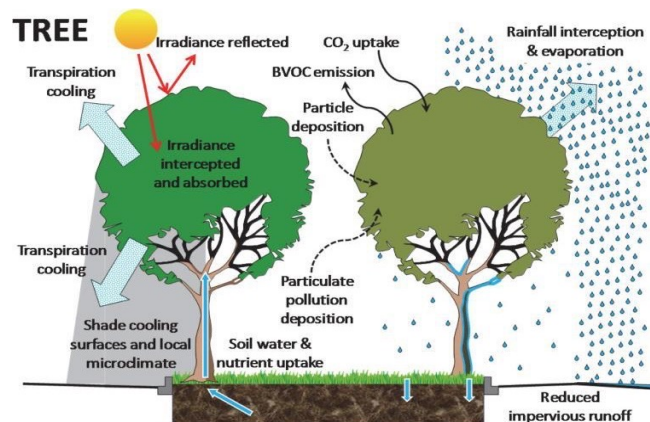


Limitations

- Require maintenance (and watering)
- Impacts strongly depend on local climate

Street Trees

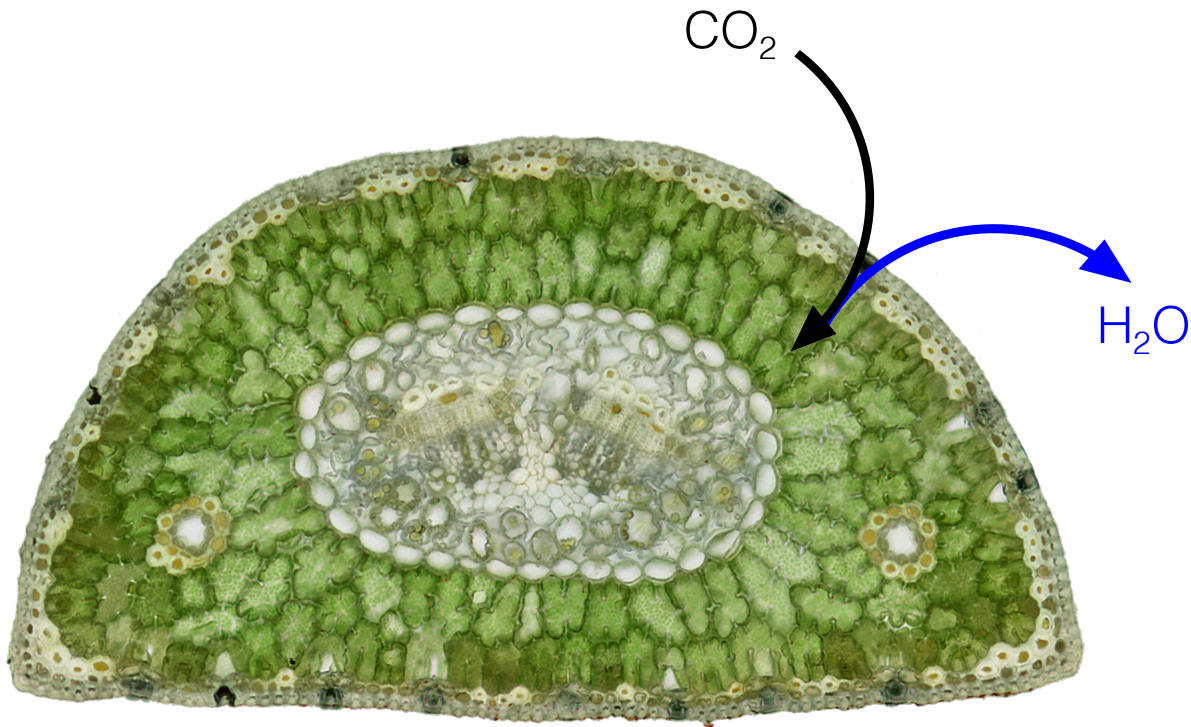
Shading + Evapotranspiration
(both benefits)



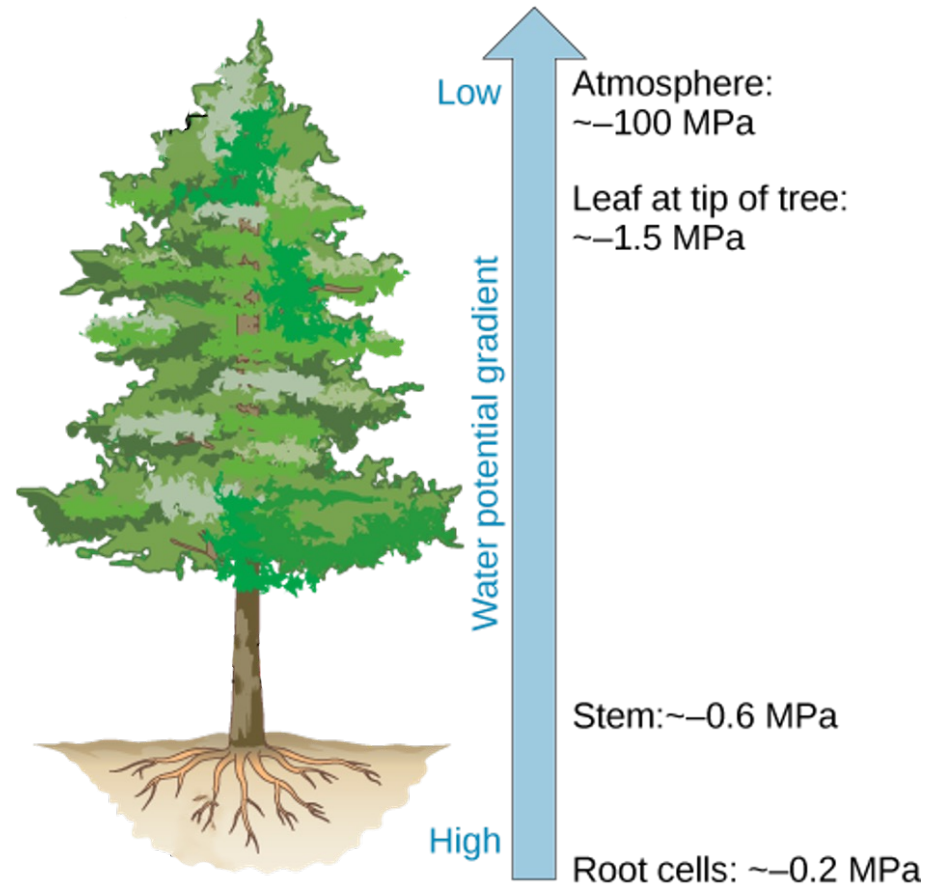
Limitations

- Require maintenance
- Compete with several city services:
 - space on sidewalks
 - underground cables and pipes
- Can hinder ventilation at pedestrian level
- Emit pollen, volatile organic compounds, etc.

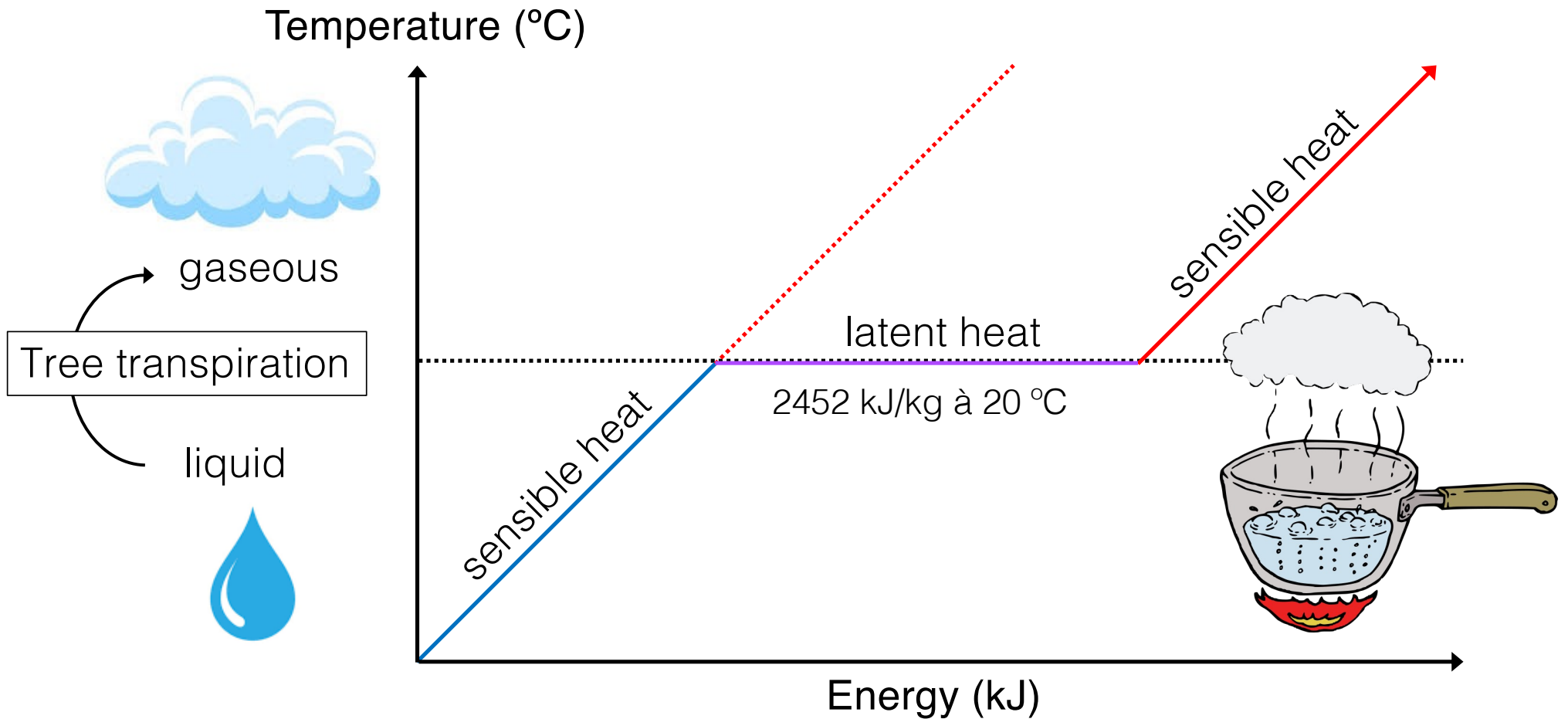
Soil – plant – atmosphere continuum



Cross-section of *Pinus nigra* needle

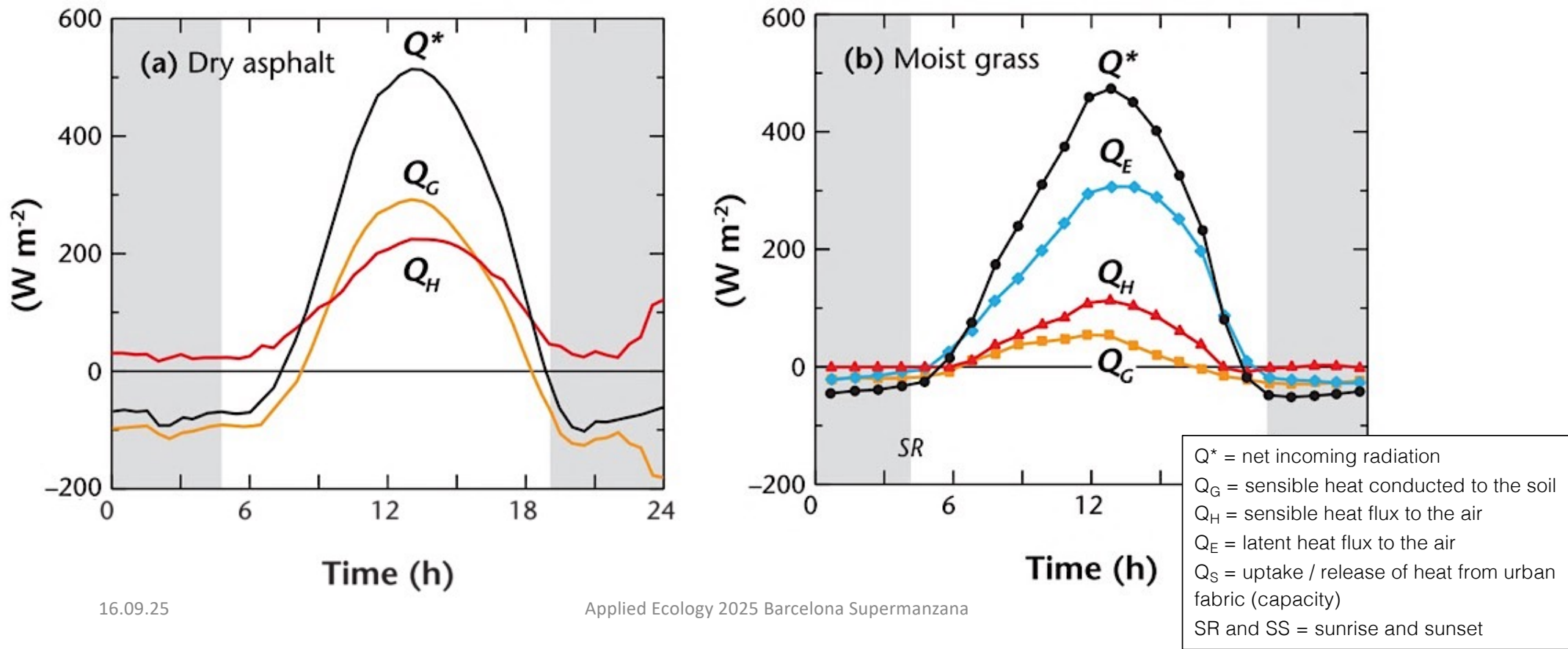


Transpiration and latent heat cooling



Sensible vs. latent heat

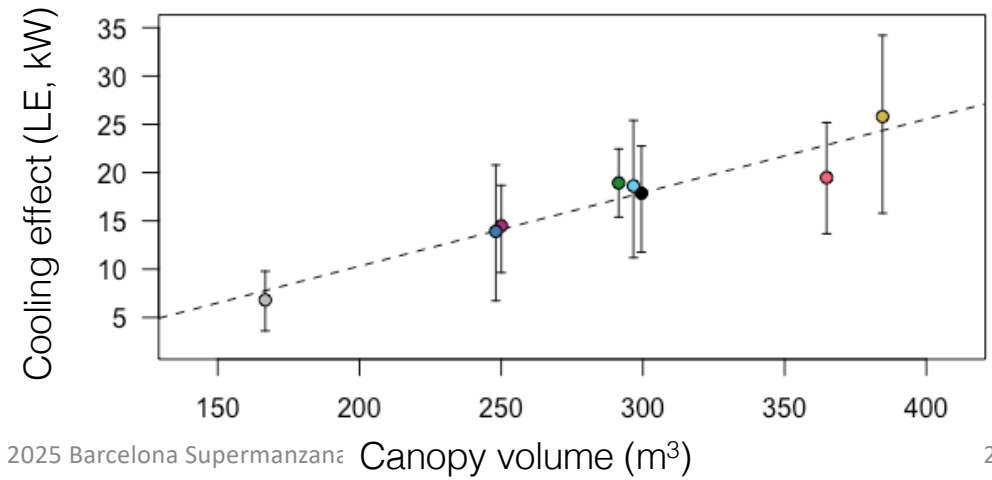
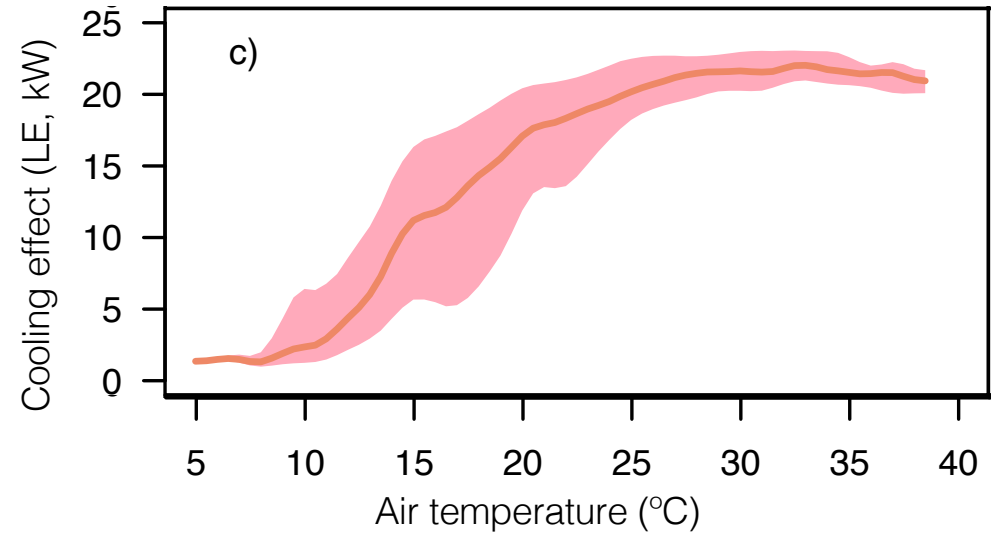
Example SEBs of unobstructed urban facets: (a) dry asphalt road near Vienna, Austria. (b) slightly moist grassed site in an urban park in Vancouver, Canada. (Oke et al. 2017)



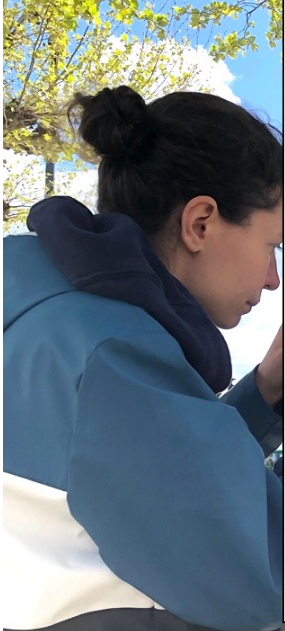
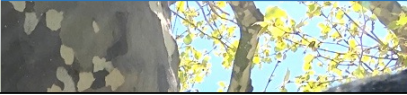
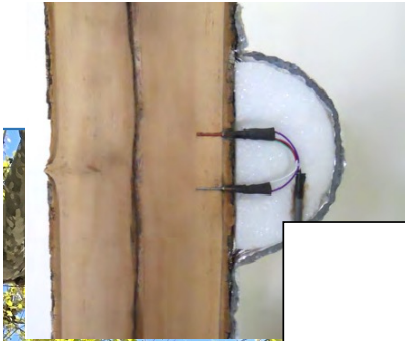
Transpiration cooling of trees



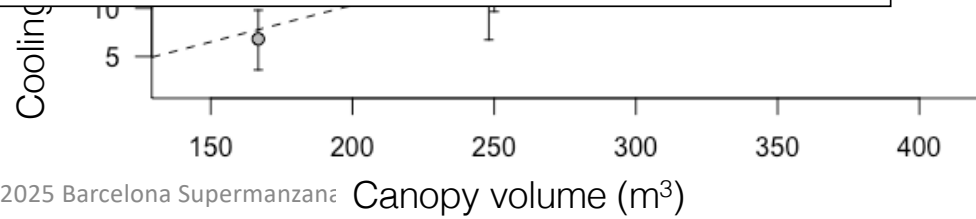
→ Up to 500 liters of water is transpired by the platanus trees per day



Transpiration cooling of trees



→ Up to 500 liters of water is transpired by the platanus trees per day



Tree species differ in cooling potential

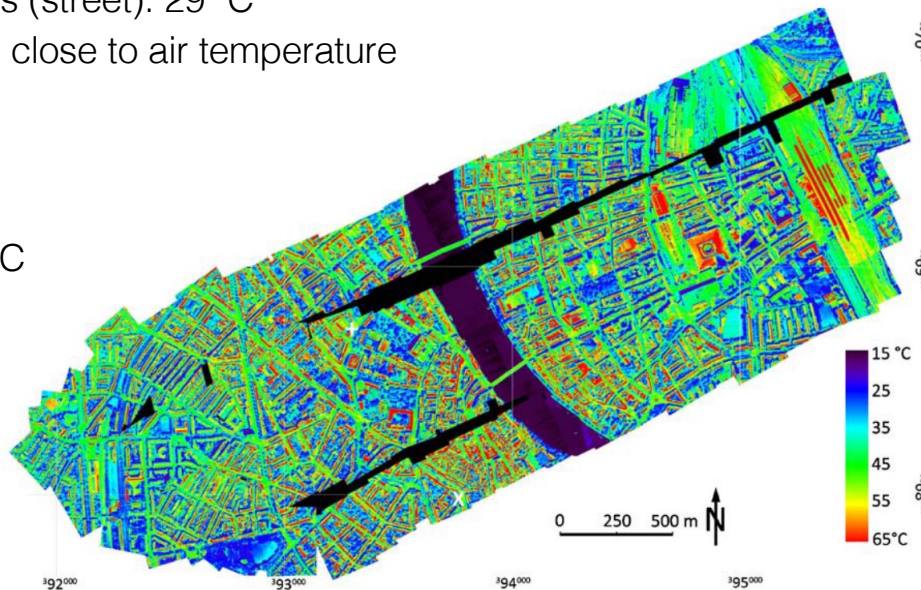
Parts of the city of Basel were scanned from a helicopter using a high-resolution thermal camera. Generally, small-leaved trees remained cooler than large-leaved trees

Crown temperatures

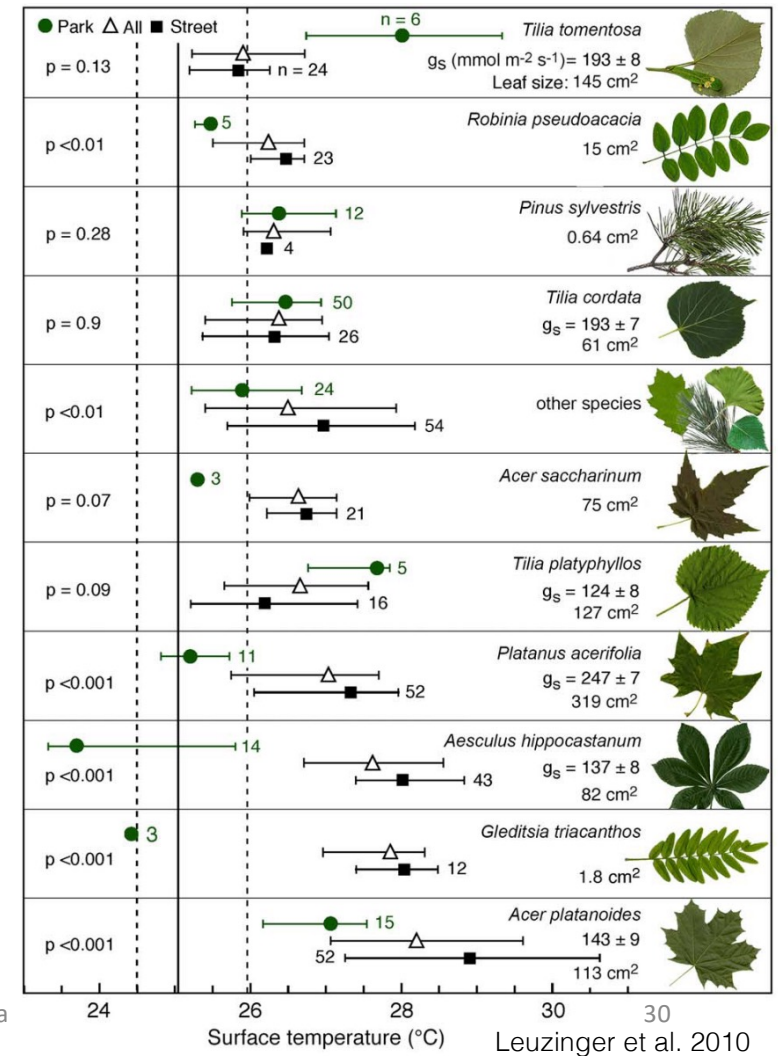
- *Aesculus hippocastanum* (park): 24 °C
- *Acer platanoides* (street): 29 °C
- *Pinus sylvestris*: close to air temperature

Peak temperatures

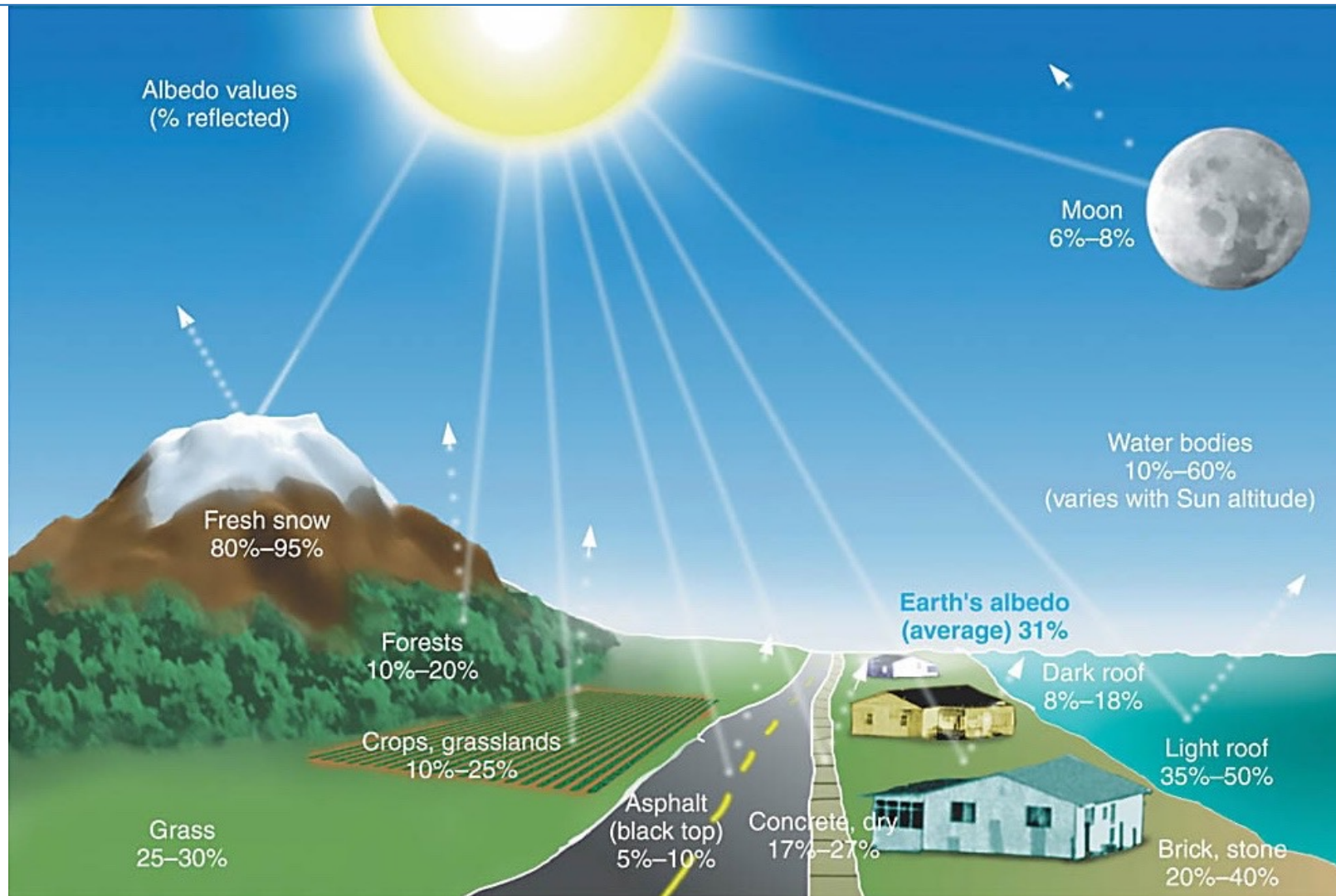
- Water: 18 °C
- Vegetation: 26 °C
- Streets: 37 °C
- Roofs: 45 °C

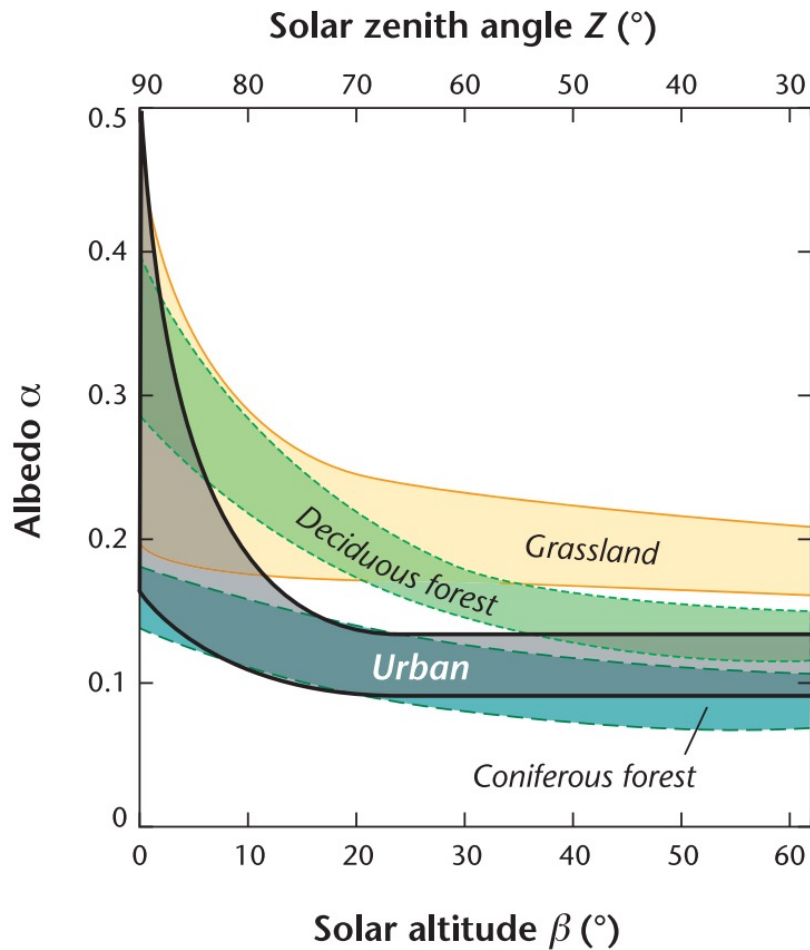


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Albedo





- In snow-free conditions urban and suburban albedo values are slightly (< 0.10) lower than in the surrounding countryside
- Cities surrounded by tropical or coniferous forest may have similar albedo

Figure 5.16 Relation between surface albedo α and solar altitude angle β (bottom axis) or zenith angle Z (top axis) for snow-free conditions.

Shade



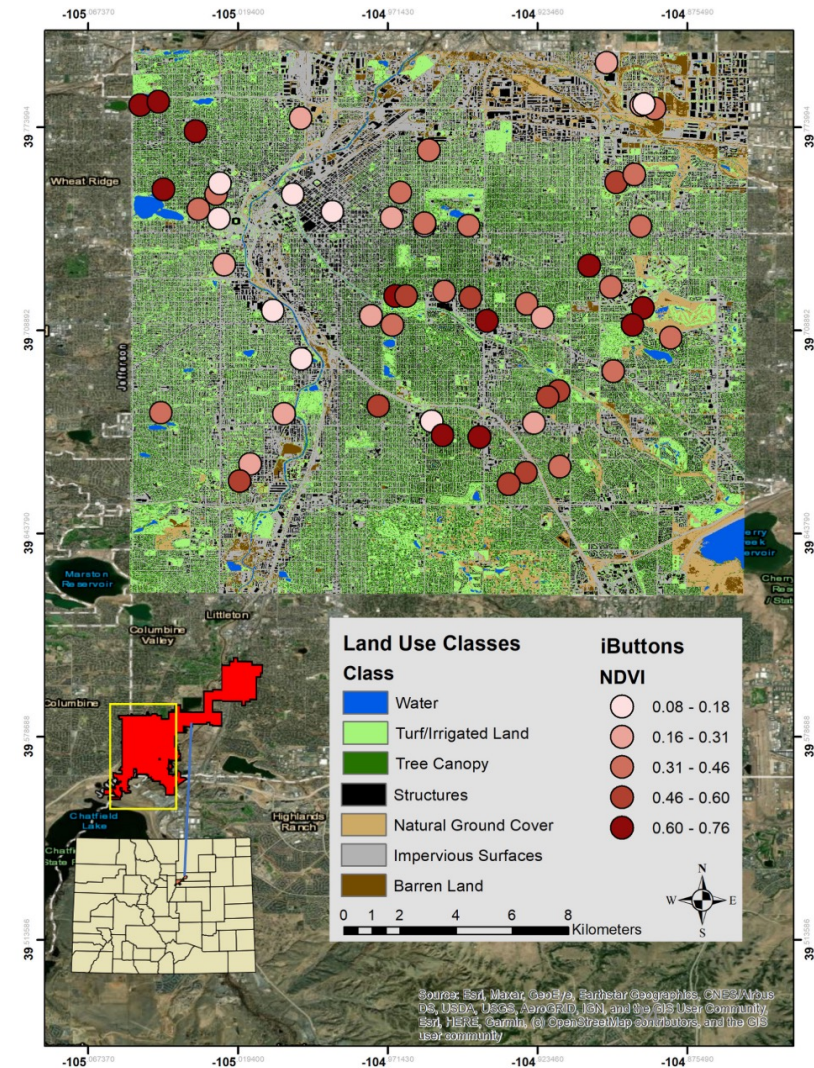
Thermal image on the EPFL campus July 2024

Shade and air temperature

- Tree canopy reduces daytime air temperatures ($-0.026\text{ }^{\circ}\text{C}$ per % cover)
- Effects are reduced to $-0.016\text{ }^{\circ}\text{C}$ at night
- Main driver of tree cooling: Canopy shades other surfaces, reducing solar radiation and stored heat
- Increases surface albedos compared to asphalt

Fig. 1. Denver Regional Council of Governments land use/cover imagery, overlaid with the iButton microclimate sensor locations (location size is visually enlarged and does not represent the exact 60 m buffer size), stratified against urban greenness (Normalized Difference Vegetation Index, NDVI).

Denver, US
Ibsen et al. 2022

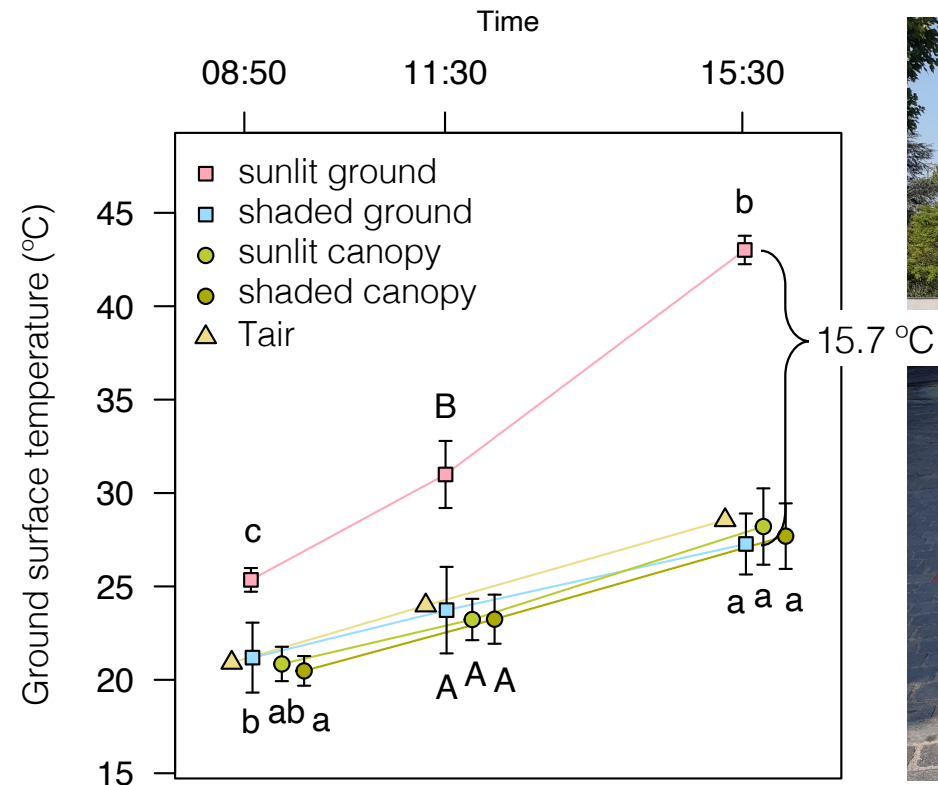


Shade, surface temperature and tree species

- Linden reduced the ground temperature more than Robinia
- Tree standing on grass: 3 °C lower LST per unit LAI (leaf area)
- Tree standing on asphalt: 6 °C lower LST per unit LAI (leaf area)



16.09.25 Munich, Rahman et al. 2019



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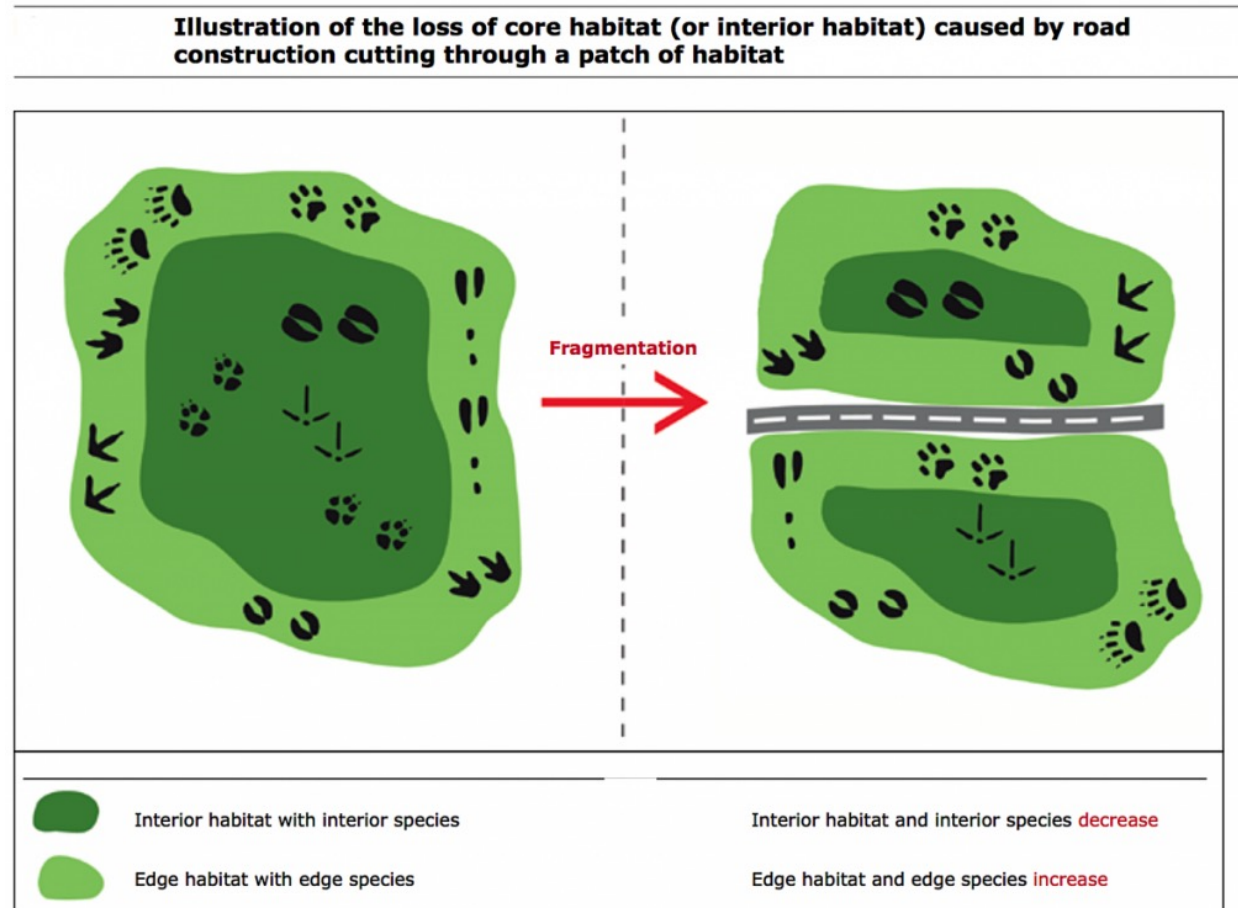


Genève 2023

Habitat fragmentation occurs when large, contiguous areas of habitat are reduced in area and divided into two or more smaller units.

The fragmented units are isolated from one another and embedded in a modified or degraded landscape.

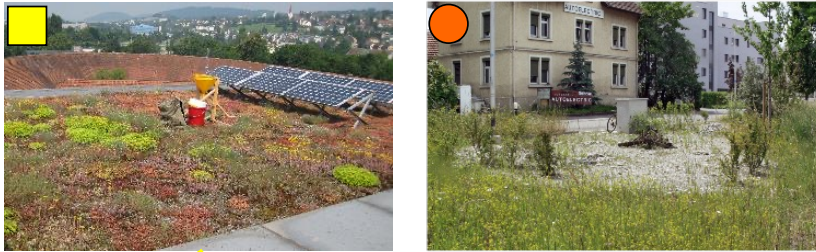
As urbanization intensifies fragmentation occurs at a finer scale through the division of habitat by roads, utility rights-of-way, railroads, and other barriers which impede movement of wildlife.



Connectivity of green spaces

Green roofs (N = 40)

Ruderal ground (N = 40)



Dispersion capacity

+++



++



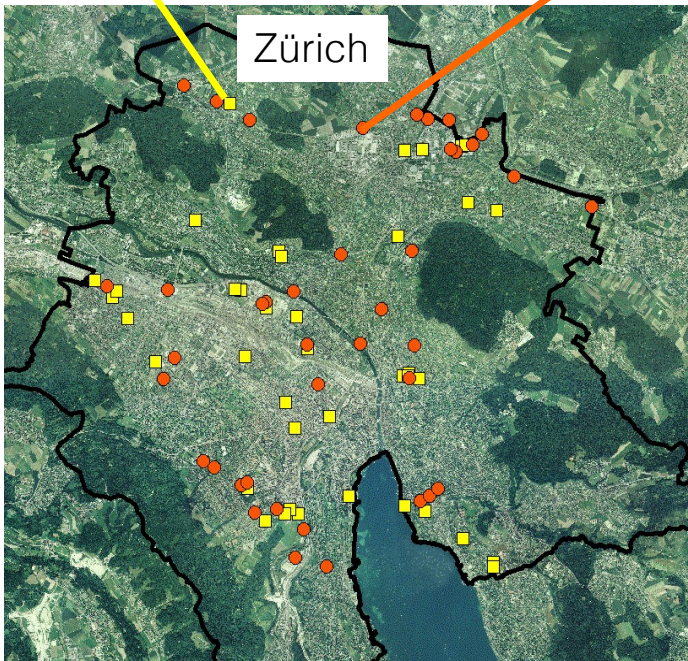
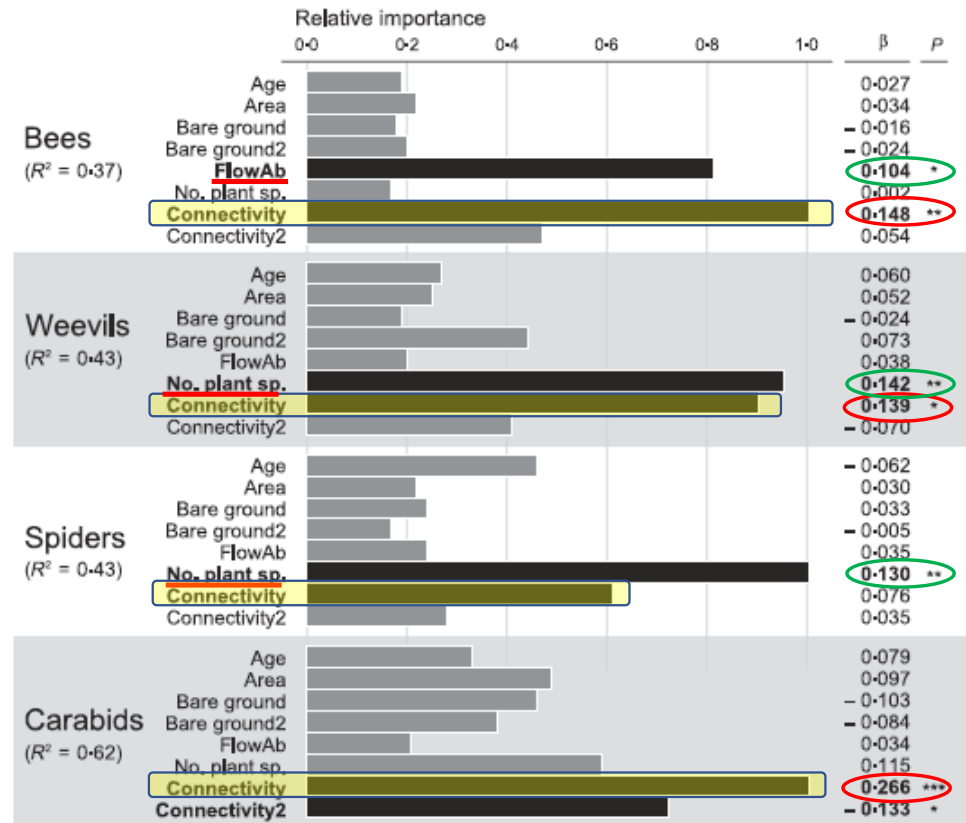
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Green roofs – Ruderal ground



16.09.25 4 km

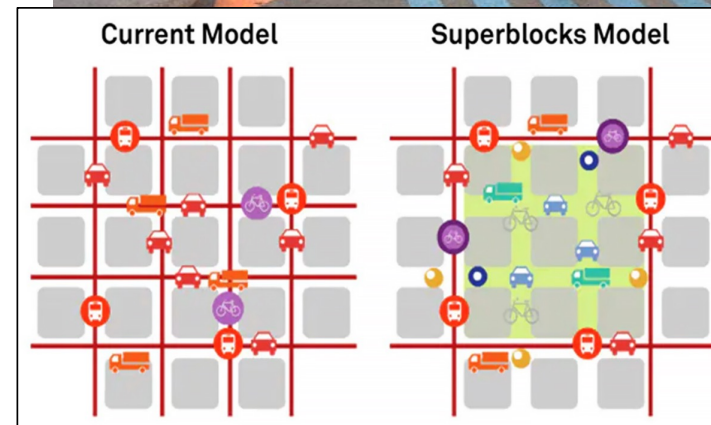
Potential solution: Superblocks and Green Axes

EPFL

Superblocks in Barcelona

Aims:

- Reduce automobile traffic and GHG emissions
- Increasing green space in the city
- Improving the health and quality of life of its inhabitants
- No investments in hard infrastructures
- No demolishing of buildings or massive development (very low-tech urbanism)
- By 2025 the Barcelona City Council has implemented six Superblocks

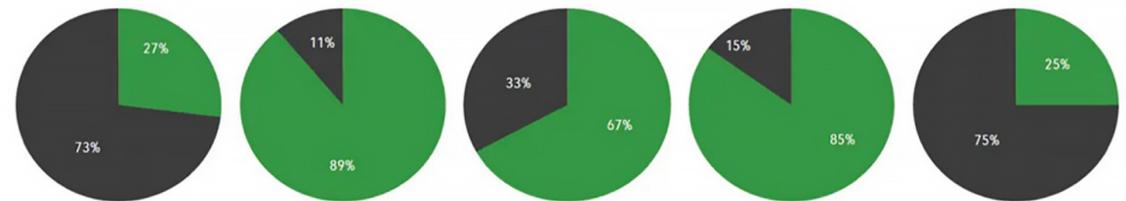


Lopez et al. 2020, Atmosphere

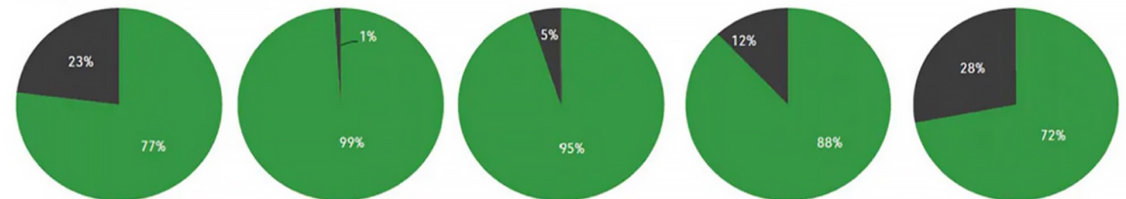
Economic effects: saving 1.7 billion € every year:

- Increased life expectancy
- 20% reduction in premature mortality
- 13% reduction in the overall burden of illness and disease

Current situation



Superblocks model



Space for pedestrians (versus road)



Accessibility (sidewalks >2,5m)



Air quality (immission <40µg/m3 any)



Acoustic comfort (Ld <65dB(A))



Liveability index in public space



Lopez et al. 2020, Atmosphere

Problems:

- Only three species make almost 50 % of the street trees: very little diversity, high risk of disease spread
- Some of the very frequently planted trees may not be sufficiently drought tolerant under future climate conditions
- Urban greening comes at the expense of traffic, there are examples of superblocks that are going to be removed again

LA VANGUARDIA

AL MINUTO / INTERNACIONAL / POLÍTICA / OPINIÓN / SOCIEDAD / DEPORTES / ECONOMÍA / LOCAL / GENTE / CULTURA / SUCESOS **SUSCRIBETE**

ENCUESTA DE IPSOS PARA 'LA VANGUARDIA'

División de opiniones en Barcelona sobre las supermanzanas de Colau

• Una mayoría de barceloneses considera que los problemas de inseguridad y vivienda se han agravado los últimos cuatro años

La calle Consell de Cent, donde el Ayuntamiento de Barcelona está urbanizando uno de los ejes verdes del Eixample (Xavier Cervera)

RAMON SUNÉ
BARCELONA

16/01/2023 06:00 | Actualizado a

Problems:

- Public opinion about the superblocks is mixed
- The city halted the development of superblocks!

→ What are possible solutions or alternatives to superblocks?

LA VANGUARDIA

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RAMON SUNÉ
BARCELONA

16/01/2023 06:00 | Actualizado a

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Controversies about Superblocks

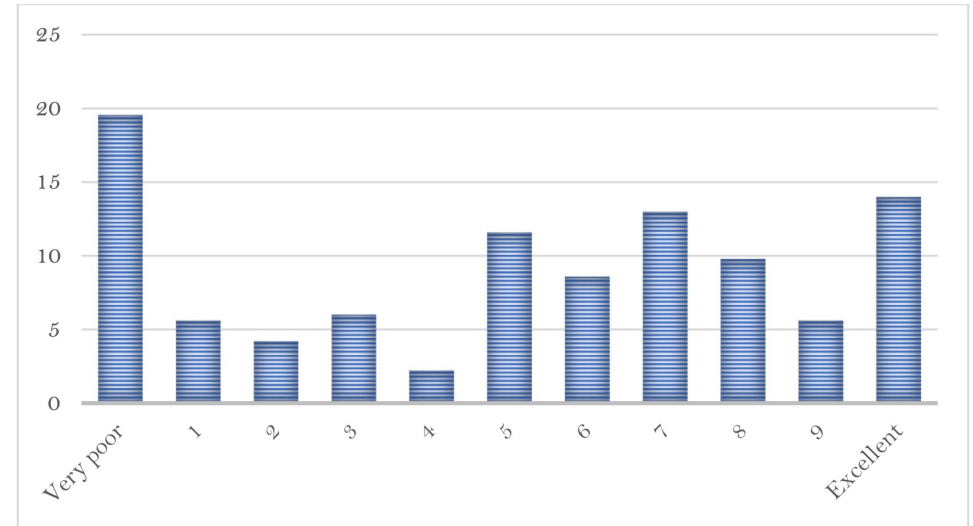
"Moving around by car is torture outright."

"It was like in the old days, like taking the kids outside to play in the street, right in front of the house."

"Businesses have been forced to close due to lack of visibility, as they are isolated and forgotten due to the lack of traffic".

"By creating a superblock you transfer traffic, noise and increased congestion to the other roads "

"Business have more people walking on the street".



Public evaluation of Superblocks (Number of participants 581)

Oltra et al. 2022

Urbanisation in China

EPFL

Critiques of Superblocks in China

1. Traffic jam in the surrounding roads
2. Superblocks isolate from the surrounding part
 - Block enclosures (gates, fences, walls or shrubs) that create physical and symbolic barriers.
3. The isolation leads to a fragmentation
 - Access between blocks is often indirect with long routes for pedestrians, cyclists and drivers. Services within the blocks (e.g. shops) are restricted to residents of the neighbourhood and are often underutilized.

Shanghai "Pudong Miracle" 1990–2010



4. Superblocks compromise quality of adjacent streets

→ Walls, gates, fences and shrubs create an unwelcoming, monotonous streetscape. Diminished opportunities for social interaction along the public streets surrounding the superblocks (e.g. deserted sidewalks).

5. Roads between blocks are oversized with limited connectivity

→ Often there is an arterial road with eight lanes or more. Roads in Chinese cities tend to have less intersections and a longer distance between them compared to European cities such as Turin, Barcelona and Paris.



Superblock neighborhoods in Shanghai are separated by wide, busy roads, deterring pedestrian activity

www.paulsoninstitute.org

Fine-grained blocks

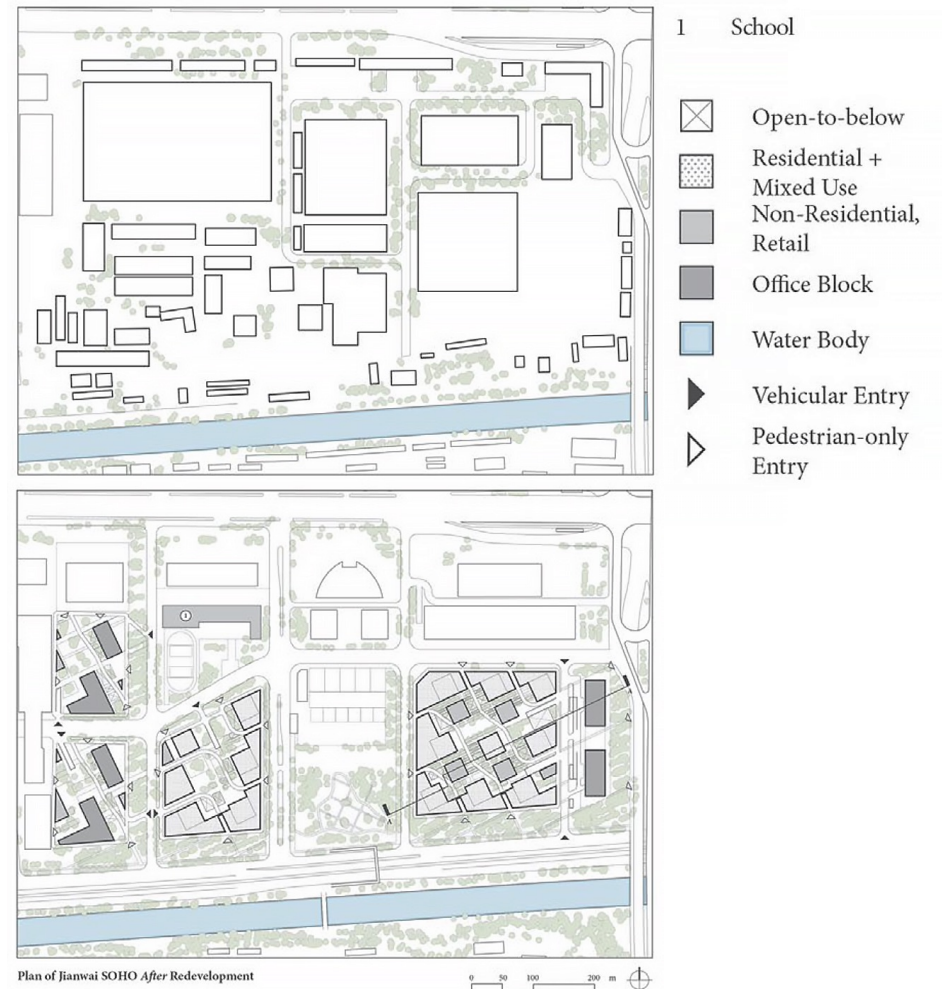
In 2016, the Chinese State Council released guidelines for moving away from Superblocks to create a finer network of urban blocks and streets.

Since the early 2000s, China has seen several development projects that have successfully reintroduced fine-grained blocks and more permeable streets.

Change in design:

- break up the regular pattern
- allow for more fine grained connections
- connectivity with the outside space

Jian Wai SOHO and the original superblock factory before and after redevelopment



From Superblocks to Green Axes

Key Features:

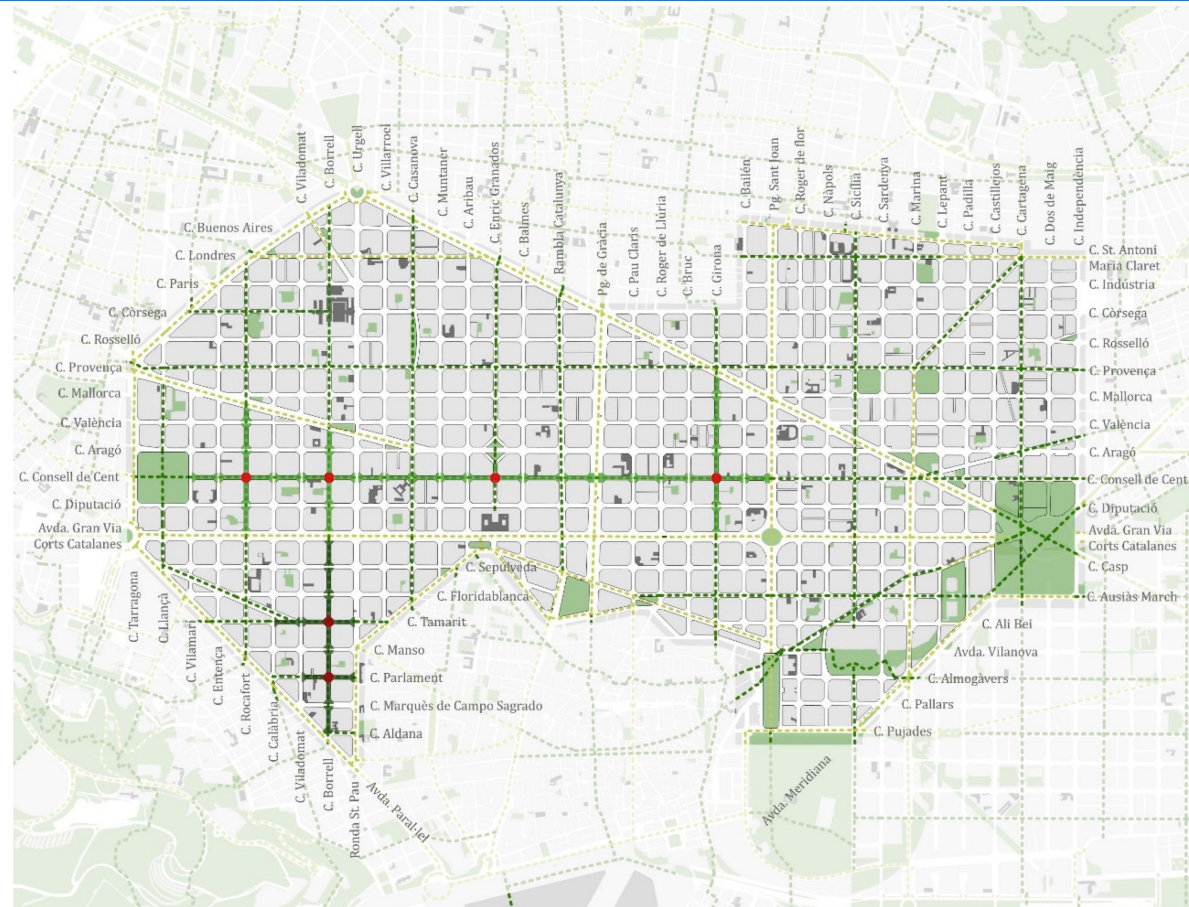
1. Prioritize pedestrians and cyclists
2. Reduce motorized traffic
3. Create interconnected ecological networks

Green Axes:

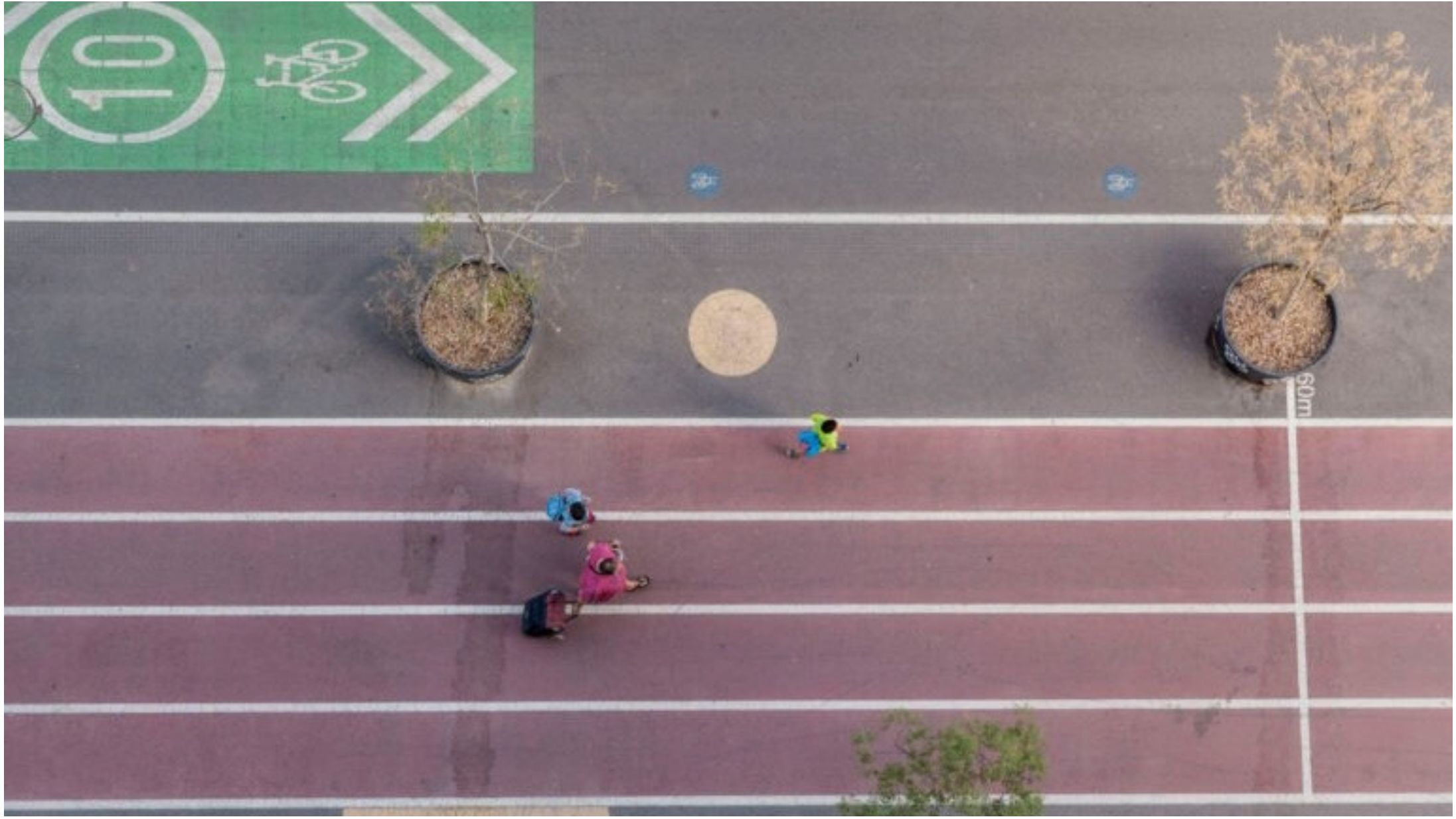
1. Add trees, shrubs, and sustainable drainage.
2. Provide shaded, walkable spaces for all residents.

Green Squares:

1. Transform intersections into 0.5-hectare community hubs.
2. Include seating, playgrounds, and recreational facilities.



Plan to execute 21 km of green axes in L'Eixample district before 2030. Green axes executed in Sant Antoni in 2018 (dark green), green axes (continuous green lines) and square gardens (red dots) to be built by 2023, and planned green axes (dashed green lines).



Additional information

Information about implementation of superblocks:

<https://ajuntament.barcelona.cat/superilles/en/content/questions-and-answers>

Map of urban trees in Barcelona:

https://jjvidalmac.carto.com/viz/c3c54164-7fcf-11e4-b04f-0e853d047bba/public_map