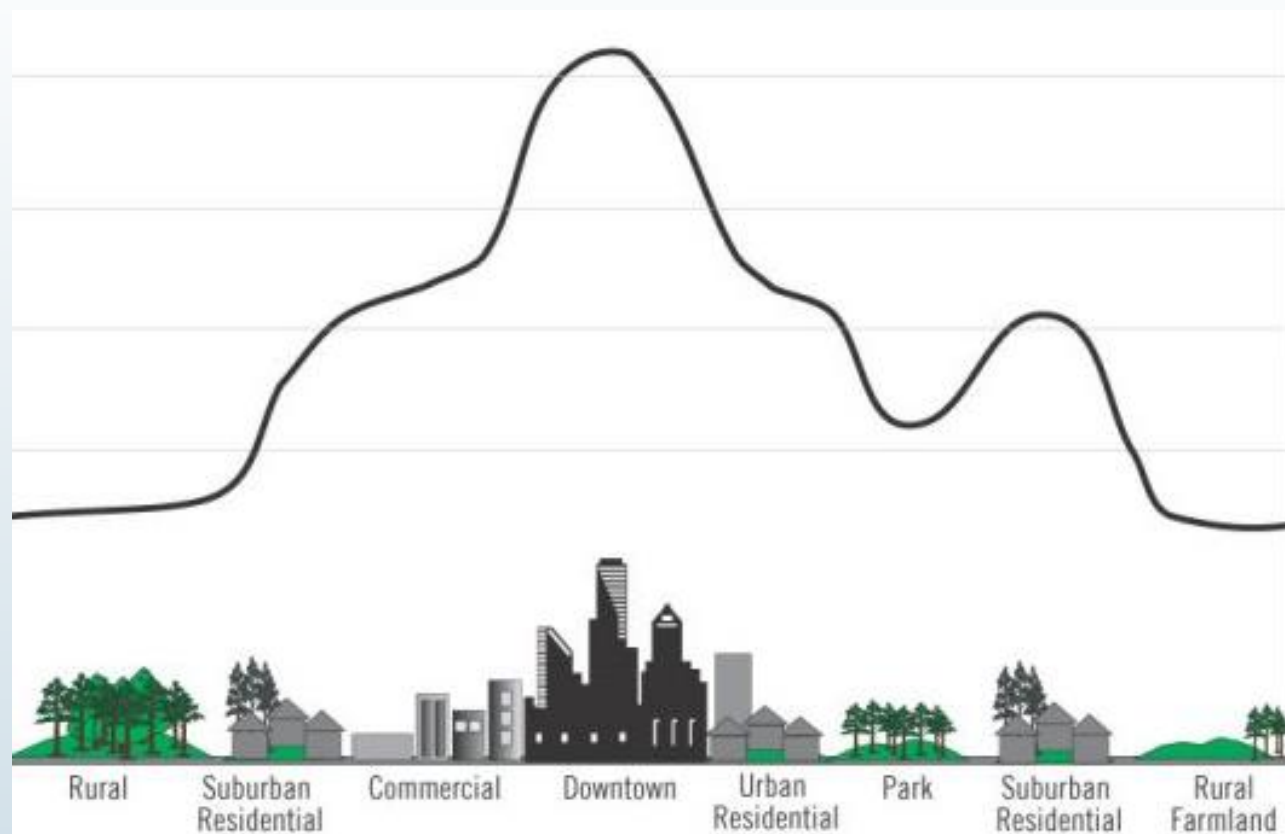


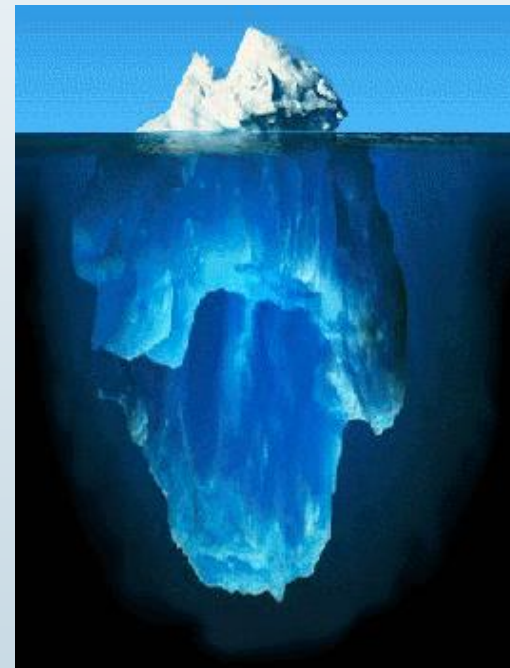
Climate change impact on the drinking water distribution network temperature

BTO

Urban heat island effect (UHI)



- Is UHI only the tip of the iceberg?
- What about the sub-surface UHI?



Source: EPA website

Background

- In the Netherlands water is distributed without chlorine.
 - 25°C is the maximum allowed temperature at the customer's tap.
- In 2006 1% of random sampling > 25°C.
- With climate change more samples may exceed 25°C.

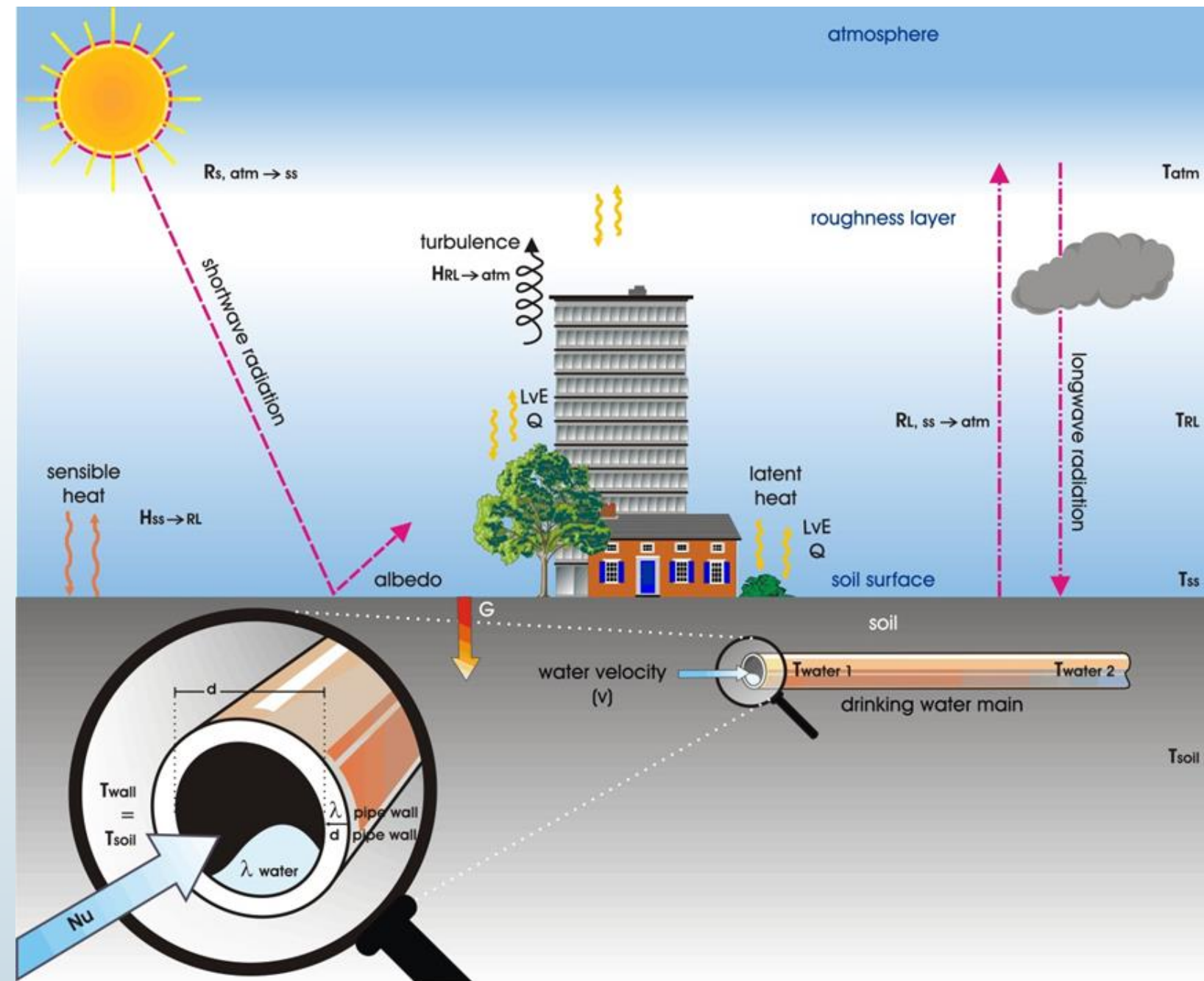


Soil temperature model

Developed by Dutch water companies
& KWR

The four heat transfer processes :

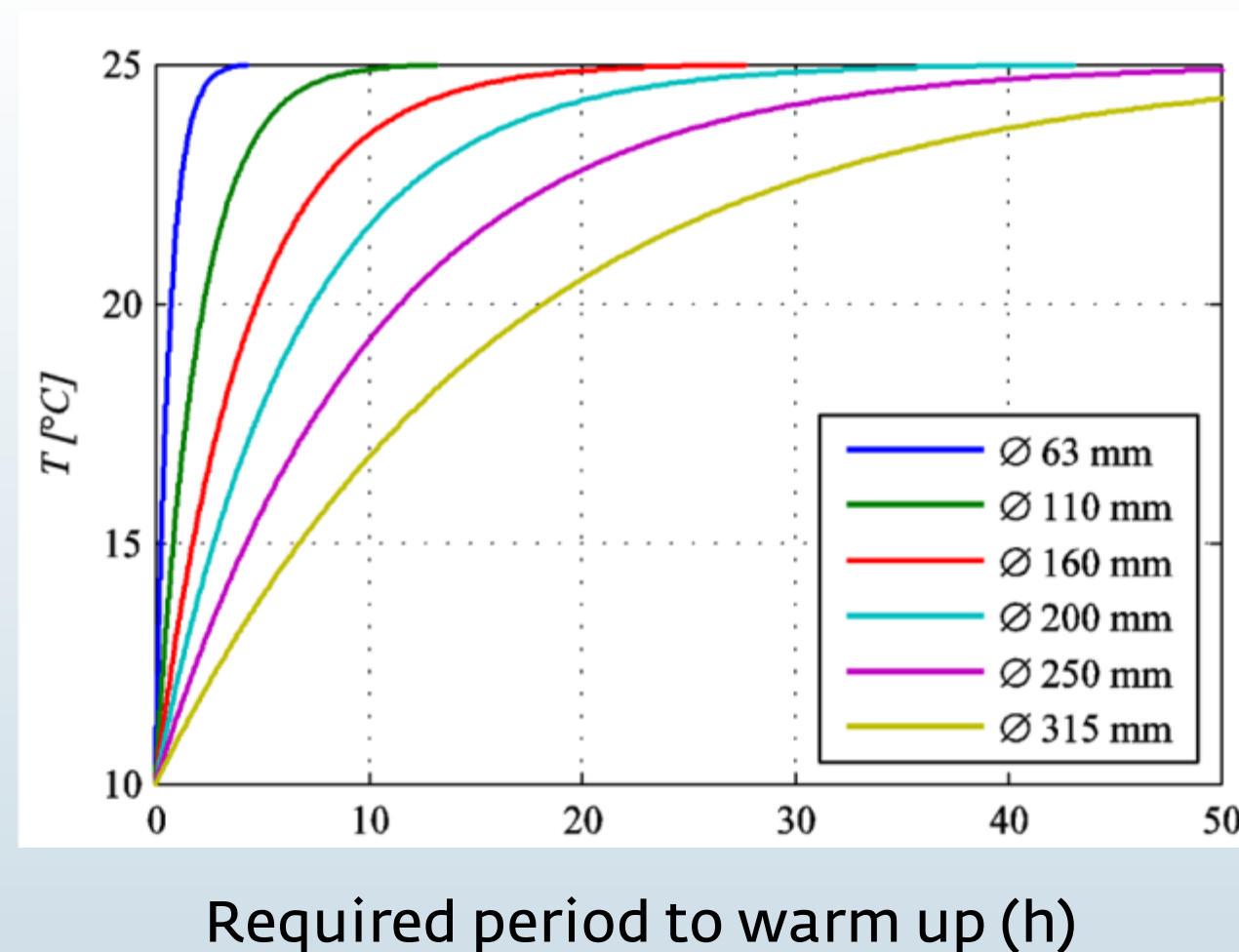
- atmosphere and soil surface
- atmosphere and roughness layer
- roughness layer and soil surface
- soil surface and soil



Blokker and Pieterse-Quirijns, 2013

Why is soil temperature important?

- Water distribution pipes are located at 1.0 m depth.
- Previous studies showed that water in small pipes reaches quickly the soil temperature



Hypothesis: Soil temperature in urban areas is higher than soil temperature in peri-urban areas

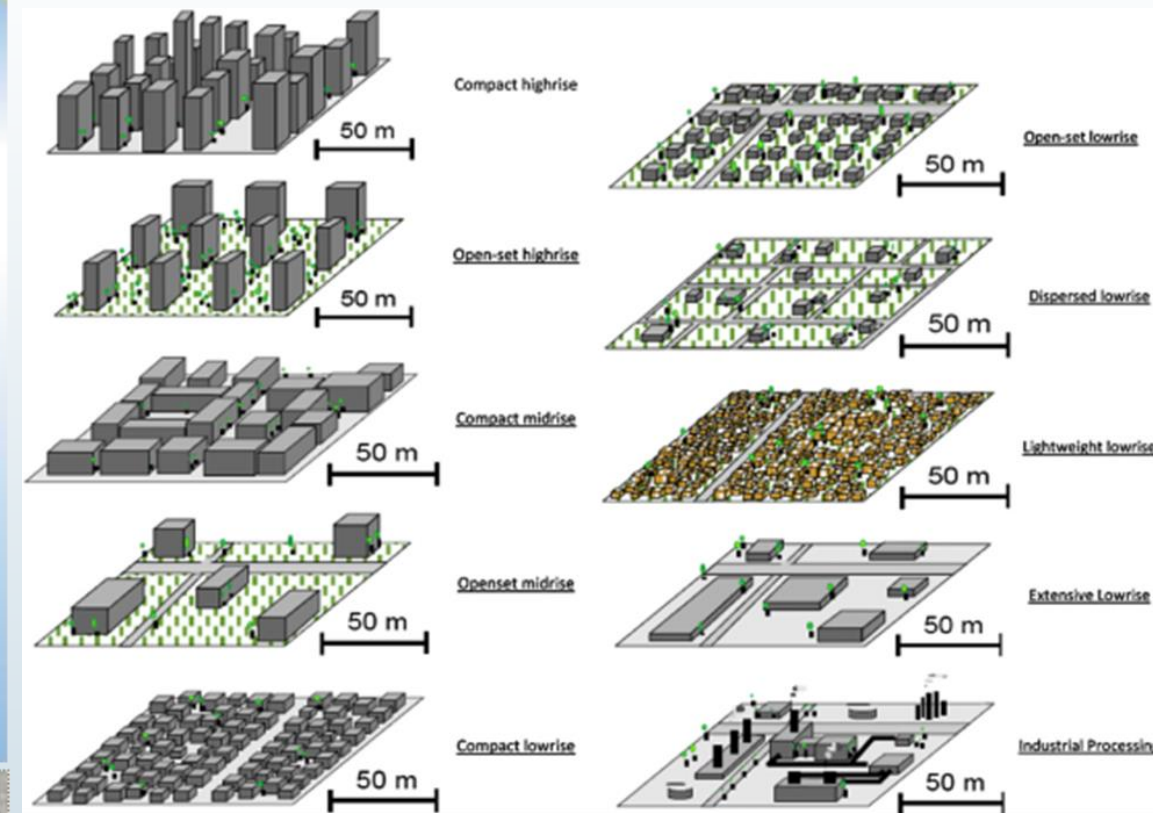
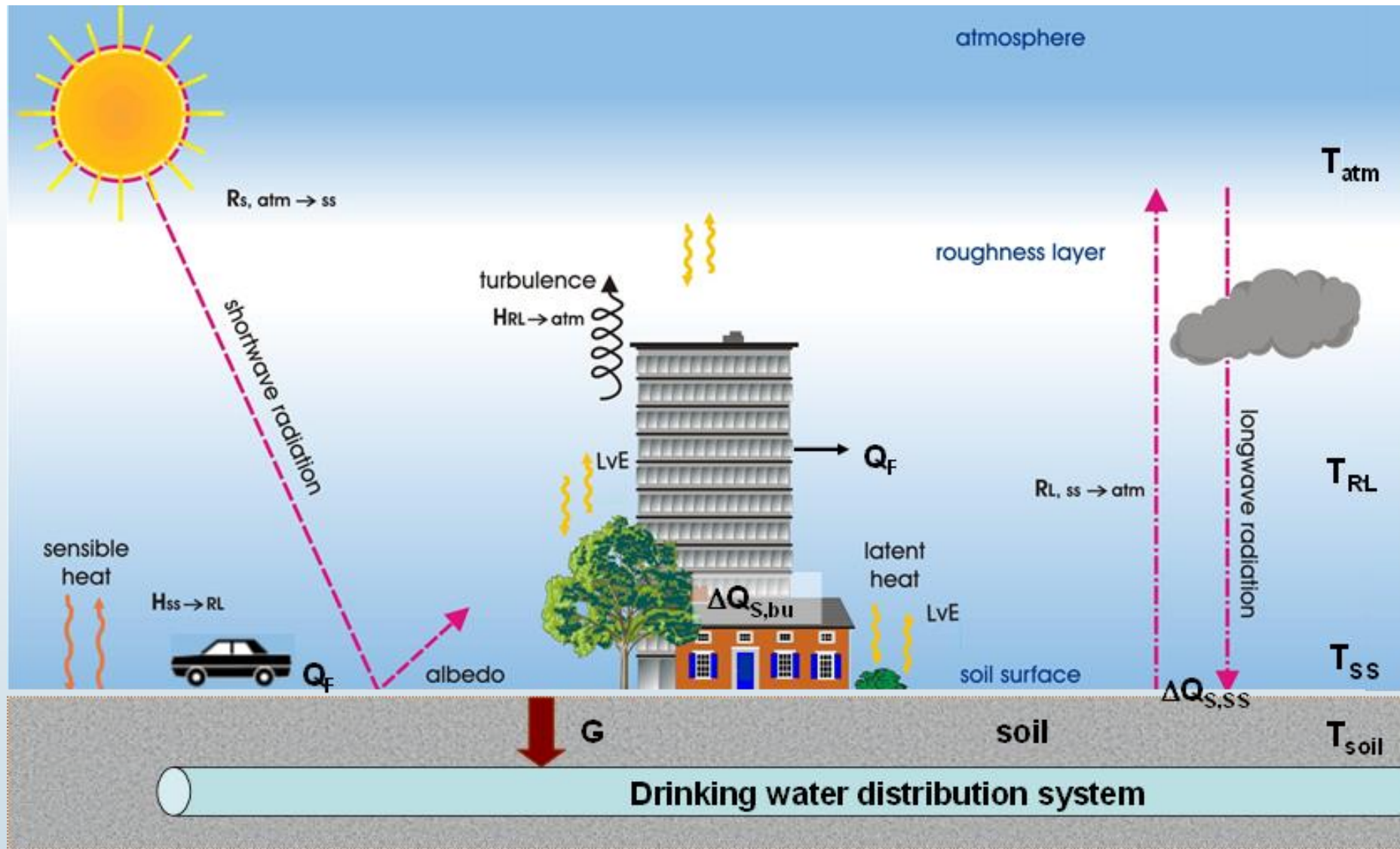
RURAL

URBAN



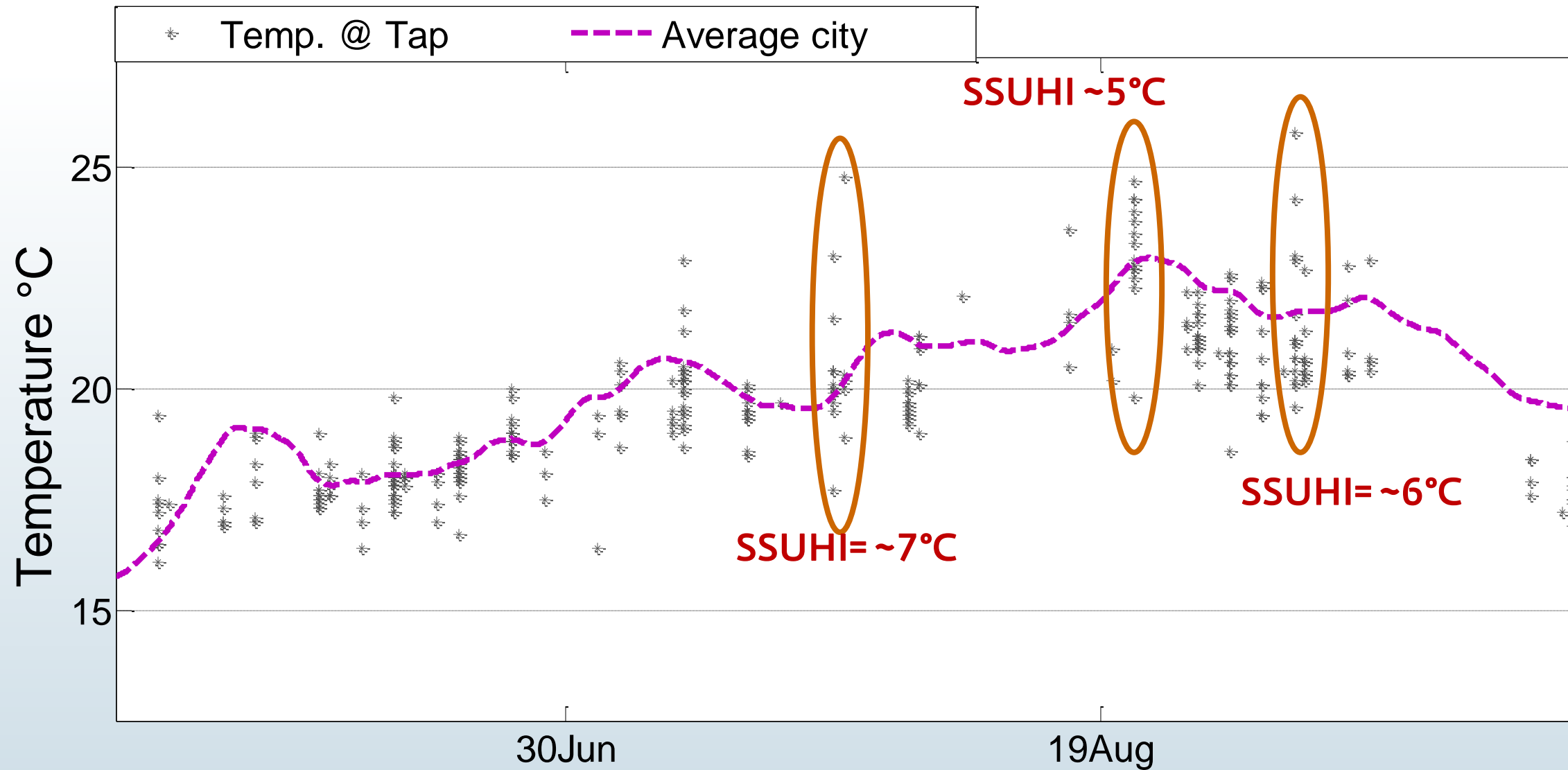
- Sandy soils in urban areas warm up more and faster than other soil types.
- UHI: limited evapotranspiration, anthropogenic heat sources and heat storage in buildings

Soil temperature model + Local climate zones



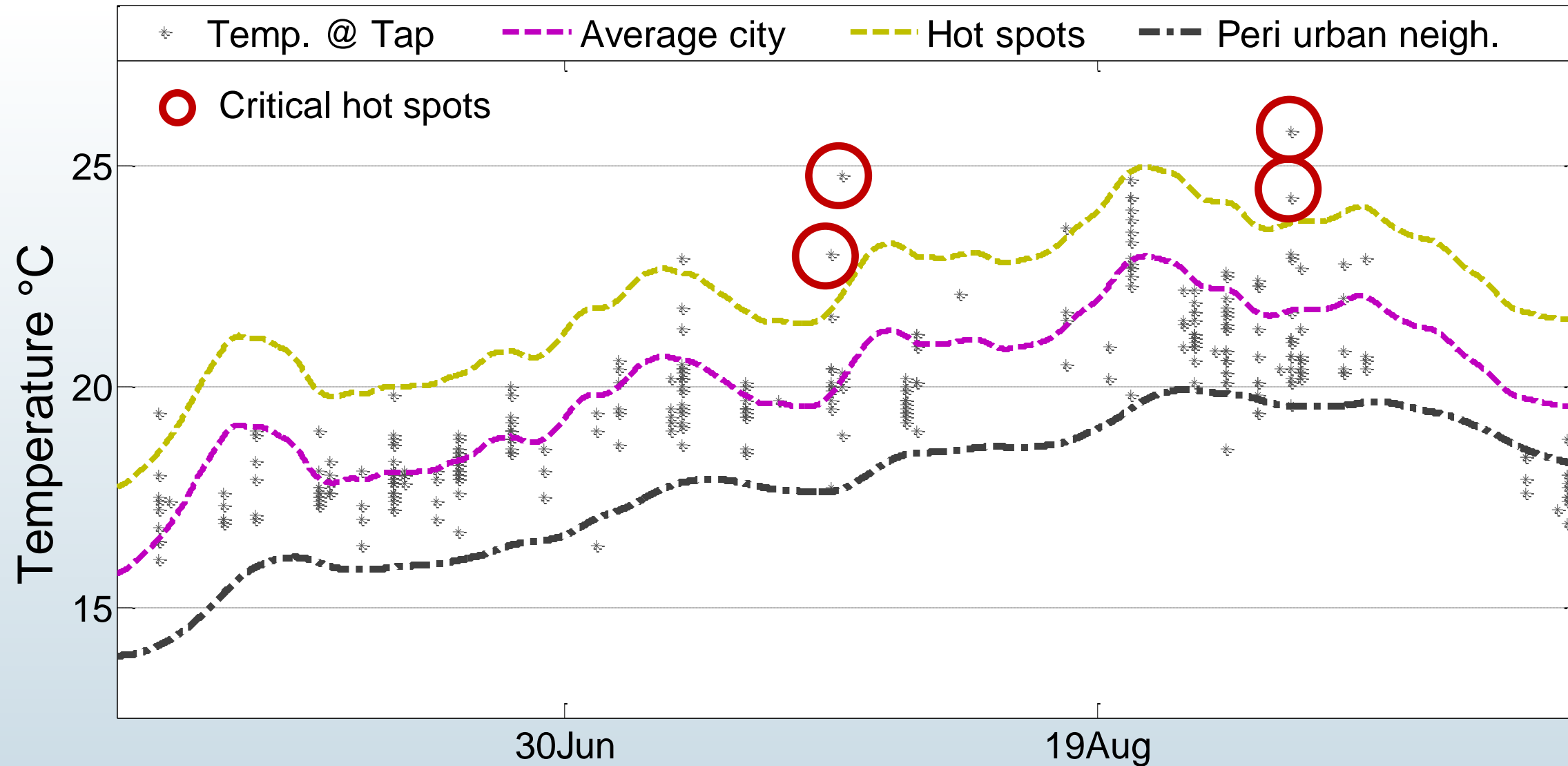
Stewart and Oke, 2009

Average soil temperature in Rotterdam in 2012



Three urban types simulated for Rotterdam

Summer 2012



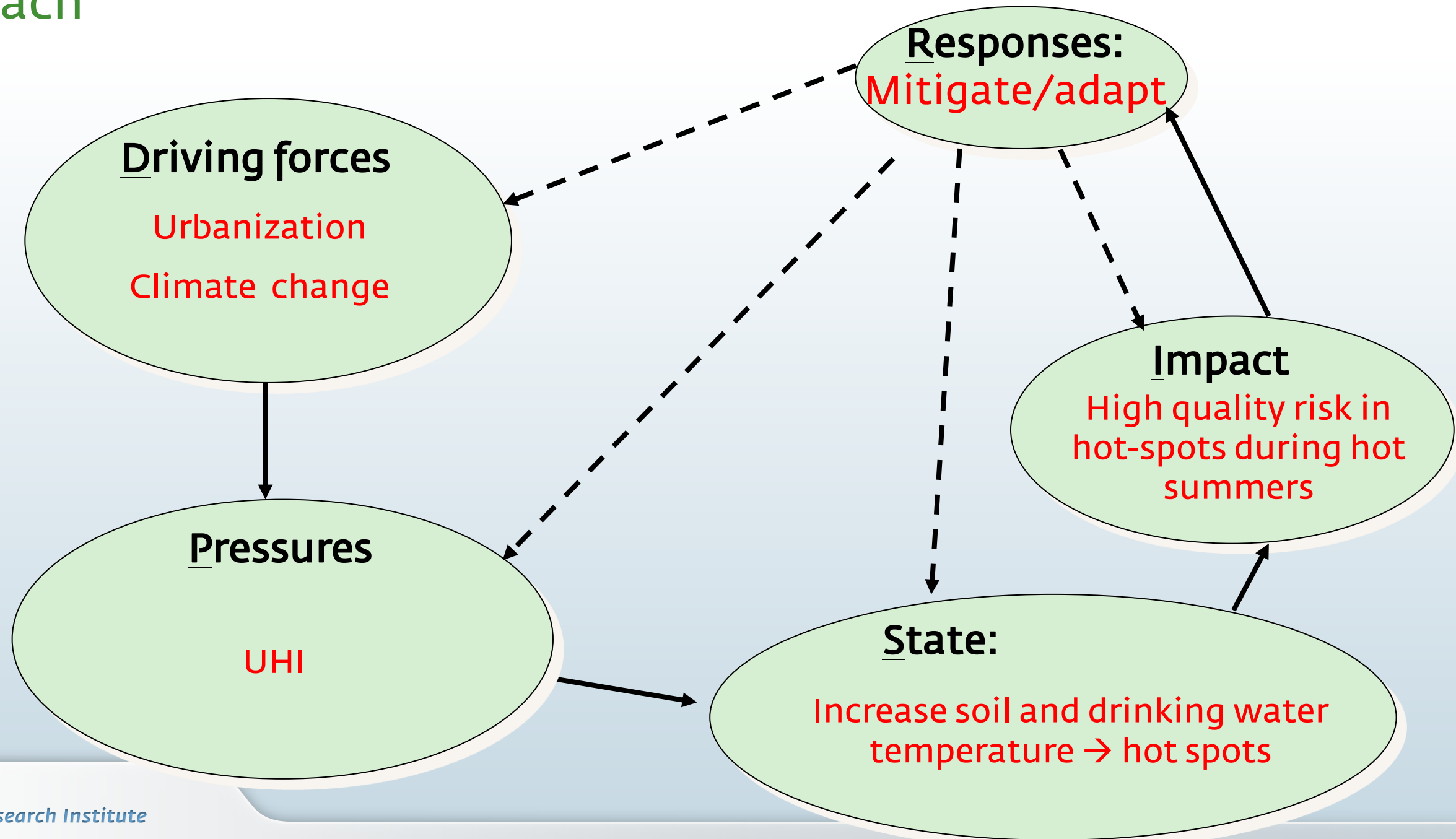
How often will drinking water temperature exceed 25°C in 2050 in a warm summer?

KNMI '06 scenario: G scenario and W+ scenario

| | Number of days drinking water T >25° | | | Number of days drinking water T >28° | | |
|---------------------------|--------------------------------------|-------------|--------------|--------------------------------------|-------------|--------------|
| | 2012 | 2050 (G) | 2050 (W+) | 2012 | 2050 (G) | 2050 (W+) |
| Peri-urban neighbourhoods | 0 | 0 | 0 | 0 | 0 | 0 |
| Average city | 0 | 0 | 7 | 0 | 0 | 0 |
| Hot-spots | 9 | 49 | 83 | 0 | 0 | 22 |

Which measures are available to limit the risk of drinking water exceeding 25°C?

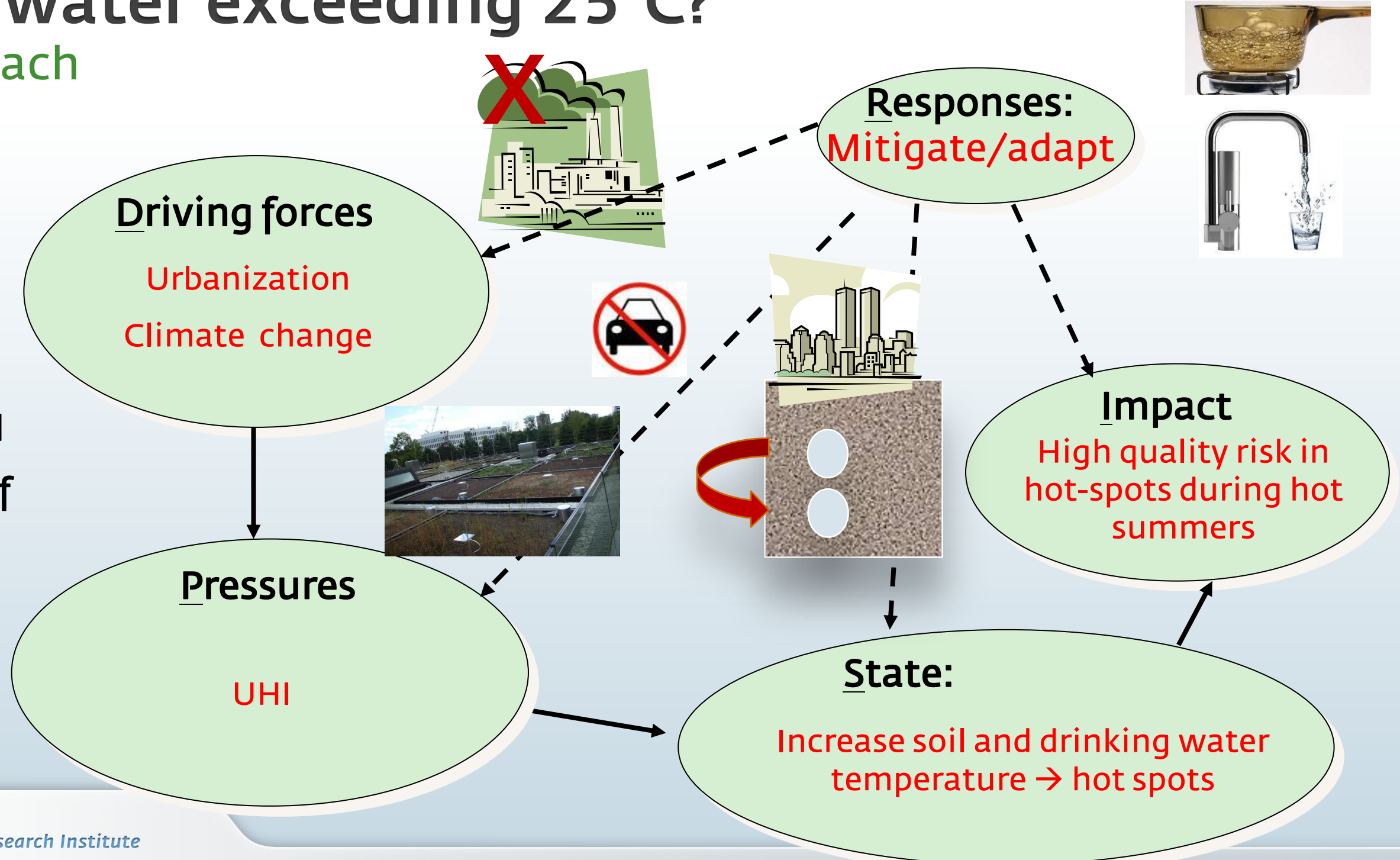
DPSIR approach



Which measures are available to limit the risk of drinking water exceeding 25°C?

DPSIR approach

- Limited effect per measure
- Need for Integral approach
- Measures do not fall under of influence of the water companies, → Crucial cooperation



Dutch water companies are front-runners

What about other countries?

- Recently Germany conducted a study to monitor urban soil temperature.
- Increasing temperature in the distribution networks can be a potential problem also in other countries
 - More research is needed.

Conclusions

- In the future, the summers are expected to be warmer, this combined with the UHI effect will influence the soil temperature.
- In peri-urban areas and average city,
 - No risk that drinking water temperature $> 25^{\circ}\text{C}$.
- Only in the hot-spots,
 - during warm summers the drinking water temperature $> 25^{\circ}\text{C}$.
- Hot-spots are a combination of dry sand and high UHI.

Take home message:

Urban heat island effect has more consequences than we know until now:

- Warming of urban soils → Sub-surface urban heat islands
- Large gradient on soil temperature at -1m & influencing temperature in the water distribution network

We have 35 years to identify and tackle the hot-spots:

- More research and monitoring: identify hot-spots & their sources
- working together is crucial to address urban challenges
 - This is already happening: Coalition for climate resilient cities (Vewin)

Thank you!
