Comparison of surface temperature over different natural and artificial urban surfaces

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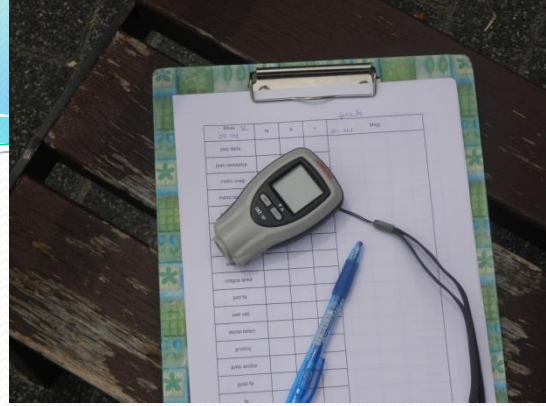
Introduction - Motivation

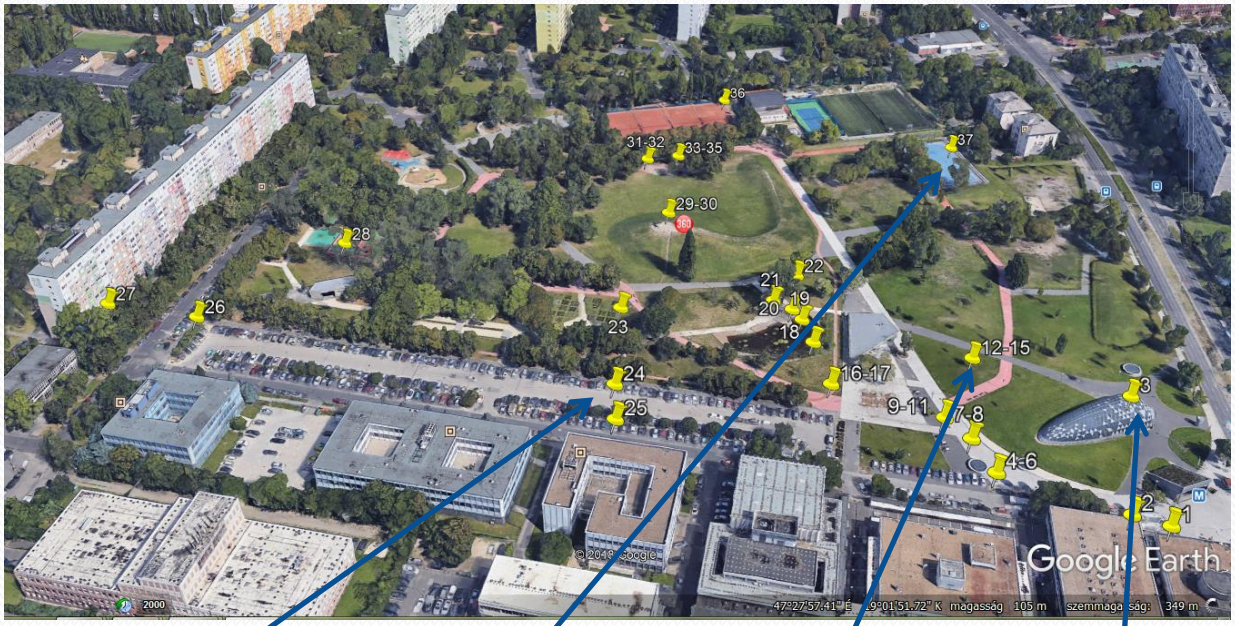
- Urban Climate Research at the Department of Meteorology Eötvös Loránd University since the late 1990s
- Regular urban climate measurements in the framework of a long-term cooperation between the University and the Department of Environment at the Municipality of Újbuda (district XI of Budapest)
- Different measurement projects in the District XI
  - UHI analysis based on satellite data
  - Air temperature measurements at different sites
  - Surface temperature measurements in a public park and in a busy transportation center

Methodology



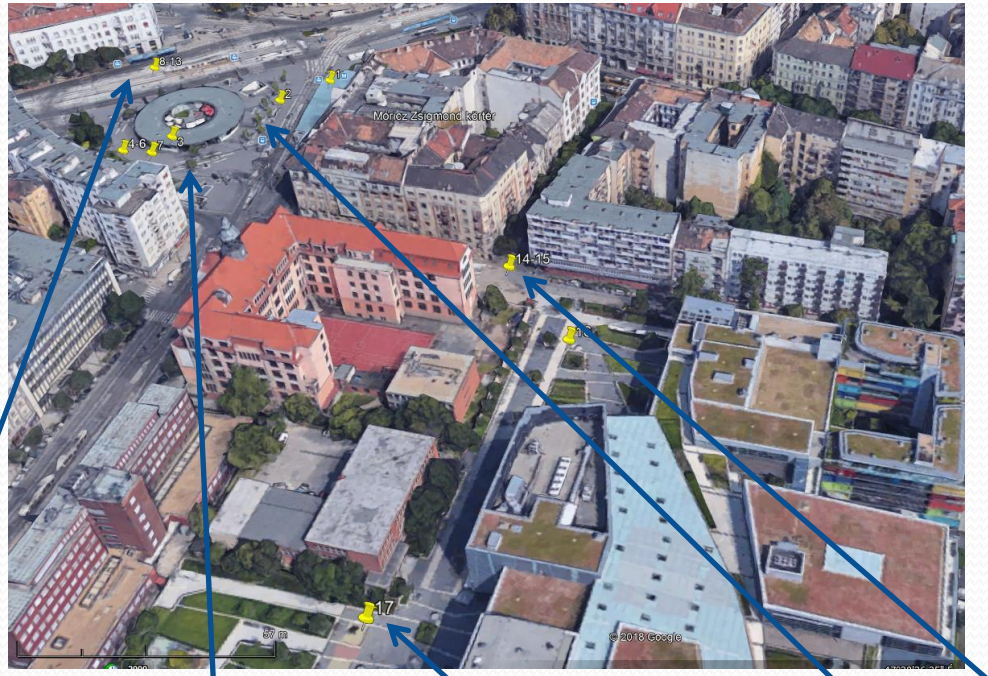
- Aim: obtain information about the thermal properties of different urban surfaces, objects
- Instrument: Voltcraft IR-280 infrared thermometer
- Measuring sites:
  - Móricz Zsigmond Square (Artificial Covered Site) -- M
  - Bikás Park (Green Park Site) -- B
- Measurement campaigns:
  - July 2-5, 2018 (four measurements per day)
  - May 17 and 23-26, 2019, June 6-7, 2019 (three measurements per day)

Measuring site – Bikás Park

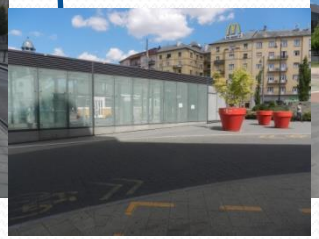
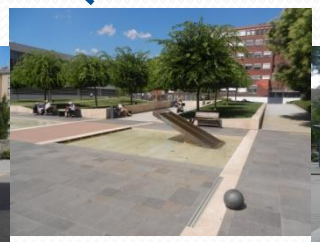


number	description	surface material
B1	market sign	concrete
B2	pillar in the market	metal
B3	subway station building	glass
B4	dark gray pavement blocks	concrete
B5	red pavement blocks	concrete
B6	gray pavement blocks	concrete
B7	dark gray pavement blocks	concrete
B8	light gray pavement blocks	concrete
B9	bench	wood
B10	bench	metal
B11	table	concrete
B12	statue of Grosics	metal
B13	lawn at the statue of Grosics	plant
B14	lawn under the tree	plant
B15	tree	plant
B16	red rubber paving	rubber+polyurethane
B17	red pavement	concrete
B18	reed	plant
B19	lake	water
B20	lake footbridge	wood
B21	gravel pavement	stone
B22	tree	plant
B23	bare soil	soil
B24	stony asphalt road	asphalt
B25	asphalt road	asphalt
B26	shrub	plant
B27	concrete building	concrete
B28	playground pavement	concrete
B29	statue of Bull	metal
B30	bare soil	soil
B31	grey rubber paving	rubber+polyurethane
B32	red rubber paving	rubber+polyurethane
B33	bicycle handlebars	plastic
B34	metal pipe	metal
B35	public workout equipment	metal
B36	tennis court cover	clay
B37	football field blue rubber paving	rubber+polyurethane

Measuring site – Móricz Zsigmond Square

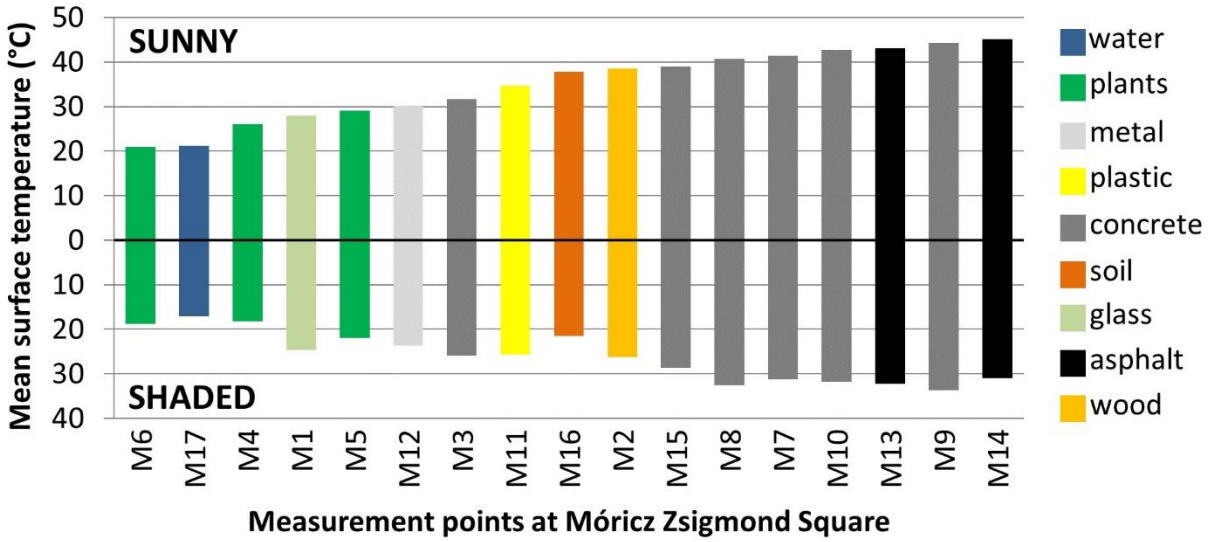


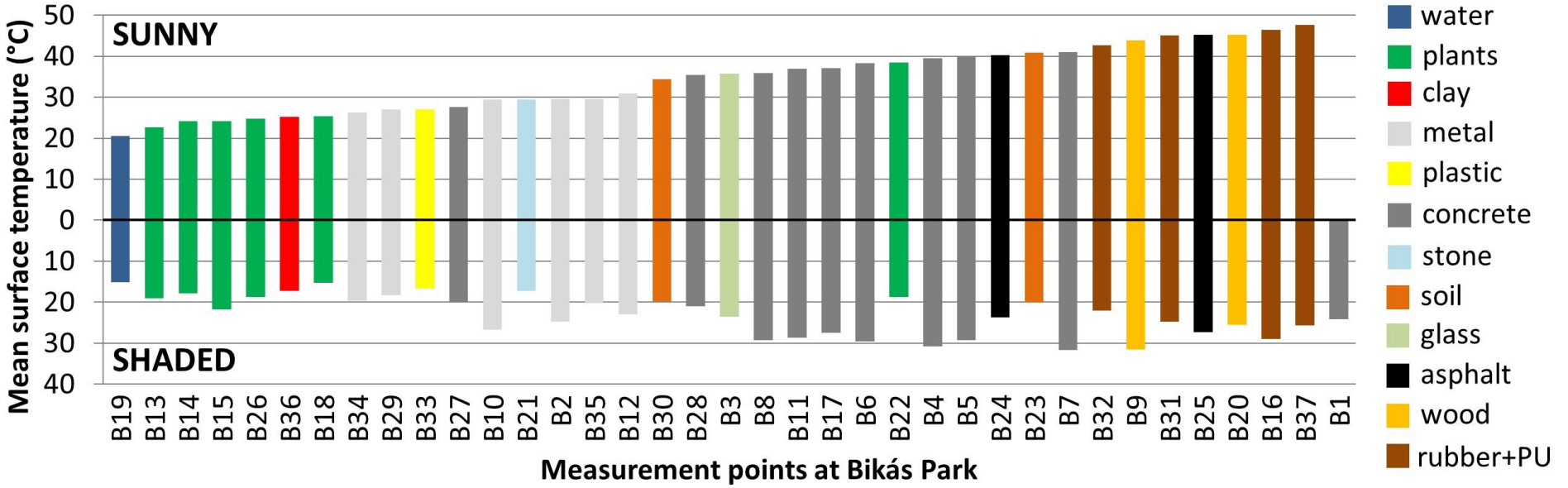
number	description	surface material
M1	subway station building	glass
M2	bench	wood
M3	Bistro wall	concrete
M4	lawn	plant
M5	tree	plant
M6	reed	plant
M7	dark gray pavement blocks	concrete
M8	red pavement blocks	concrete
M9	blue pavement blocks	concrete
M10	gray pavement blocks	concrete
M11	handrail	plastic
M12	tram rail	metal
M13	asphalt pavement between tram rails	asphalt
M14	road	asphalt
M15	light gray pavement blocks	concrete
M16	bare soil at Allée shopping center	soil
M17	water surface at Allée shopping center	water

Results

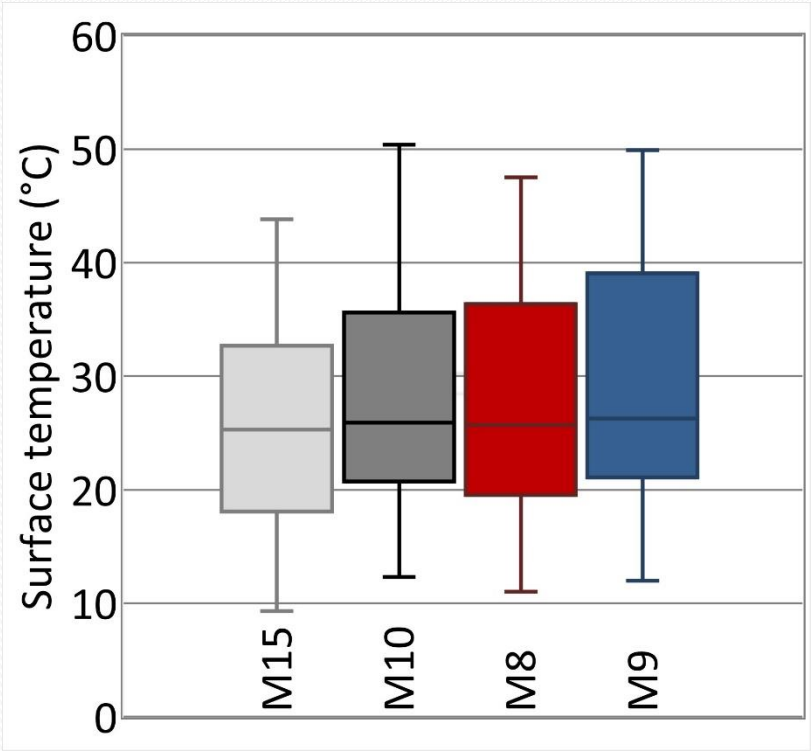
Mean surface temperature of measurements around noon. Colours indicate the surface materials of the points. The upper part of the diagram (positive direction) represents the sunny, while the lower part (negative direction) represents the shaded measurements at the same point.





Results – The role of colours

Surface temperature distribution of concrete pavement surfaces of different colours at Móricz Zsigmond Square.
The box-and-whisker diagram includes the minimum and the maximum (bottom and upper end of the whiskers, respectively), the lower and upper quartiles (bottom and top of the box, respectively) and the median (line inside the box) of all the available data.
The colours of the pavement blocks: M15 – light grey, M10 – grey, M8 – red, M9 – blue.



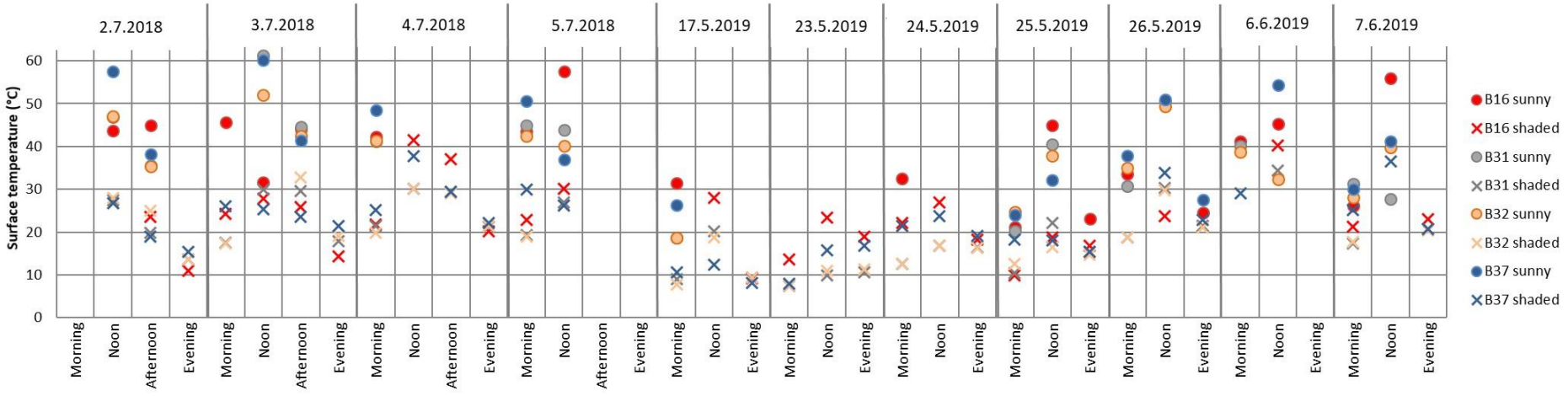
Results - The role of colours and shading

Surface temperature measurements of different rubber-paved surfaces at Bikás Park measuring site.

Circles and crosses represent temperatures at sunny and shaded points, respectively.

The colours of the rubber surfaces are as follows:

B16 – red, B31 – grey, B32 – red, B37 – blue.



Conclusions

- Detailed statistical analysis was performed to investigate the thermal properties of various urban surfaces, e.g. pavements, walls, street furniture, sport facilities, water and plant surfaces.
- **Extremely high surface temperatures** can occur **in summer**, especially when the surface is directly exposed to sunlight.
- The hottest points are **dark painted wood** objects, **asphalt** and **rubber**-paved surfaces with sunny conditions, the coolest surfaces are natural covers, i.e. **water** and **vegetation** surfaces.
- In the case of most materials, **shading reduces the surface temperature** substantially.
- Surface **colours** definitely **influence the thermal properties**; thus choosing the appropriate colour can effectively reduce the surface temperature.
- Our study showed that the adverse effects of the urban climate can be effectively mitigated
  - by selecting appropriately the covering materials,
  - by increasing the proportion of natural vegetation and water surfaces,
  - by appropriate shading of surface covers with less advantageous thermal properties.

Thank you for your attention!

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MSc students of the Eötvös Loránd University:

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