Building Climate Resilience through Urban Climate Analysis. Case study: Galanta (Slovakia)

INTRODUCTION

The study of the urban climate has a great importance in the context of climate change, where increasingly frequent and intense extreme thermal events will generate lethal effects in cities. Central European cities face intensifying urban heat island effects driven by dense built environments, sealed surfaces, and rising temperatures, which worsen heatwaves and thermal stress [1]. Loss of urban green space and biodiversity reduces natural cooling, stormwater retention, and residents' well-being, while energy demand spikes for cooling strain grids and increase emissions.

Variations in radiative, thermal, hydrological, and aerodynamic properties cause urban areas to be several degrees warmer than suburban areas. This difference appears in daily average temperatures but varies also throughout the day, generally becoming more pronounced during the evening and nighttime hours.

Thermal imagery and precise thermal monitoring provides actionable evidence for urban planners and public-health officials: it supports heat-risk zoning, prioritizes vulnerable neighbourhoods for cooling investments, and informs emergency response during heatwaves [2].

OBJECTIVES

This initial study has two principal objectives:

- ✓ Map the microclimate of urban and suburban areas in Galanta (Slovakia) to understand local variations in temperature.
- ✓ Create a detailed thermal map of the city's urban area to identify heat patterns and potential hotspots.

ID	AREA	LAND-USE CATEGORIES	SURFACE
1	suburban	composting plant	mixed
2	urban	collection yard	mixed
3	urban	city park	urban greenery
4	urban	housing area	mixed
5	urban	parking lot	paved area
6	urban	city square	paved area
7	urban	city park	urban greenery
8	urban	housing area	urban greenery
9	urban	kindergarten/playground	mixed
10	urban	schoolyard	urban greenery
11	urban	schoolyard	urban grassland
12	suburban	kindergarten/playground	mixed
13	suburban	agricultural field	arable land
14	suburban	discontinuous housing area	mixed
15	suburban	community centre, near water	mixed
16	suburban	forest	greenery
17	suburban	community centre	mixed
18	urban	housing area	mixed
19	suburban	vineyard, near water	greenery

Table 1. *An overview of the research sites*

METHODS AND STUDY AREA

This study presents a comprehensive characterization of the urban climate of Galanta, Slovakia. The municipality covers approximately 33 km², of which about 6.5 km² are urbanized, and lies within one of Slovakia's warmest and driest lowland regions. The city's relief is essentially flat and homogeneous.

A network of nineteen *Solinst Model 3001* thermal dataloggers continuously measured air temperature at ten-minute intervals from August 2025 through the end of February 2026. The deployment strategy was stratified according to surface characteristics and land-use classifications to achieve representative spatial coverage across the city's heterogeneous environmental conditions. Of the total dataloggers, eleven were positioned in urban settings and eight in suburban locations (Table 1).

Thermal imagery of the urban area was acquired on 14 August 2025, a day that registered exceptionally high temperatures in the monitoring network (maximum recorded temperature 36.3 °C) and was used to spatially contextualize point measurements and to identify locations exhibiting elevated surface temperatures (Figure 1).

For each monitoring location, the time series data were processed to derive minimum, maximum, and mean temperatures, diurnal temperature cycles, and metrics describing temporal variability. Comparative analyses between urban and suburban sites were conducted to quantify spatial contrasts and to assess the intensity of the urban heat island effect across differing urban morphologies.

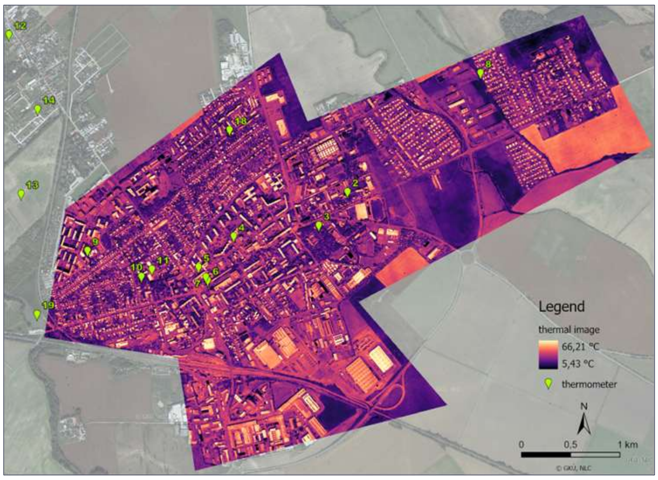

Figure 1. *Thermal image of urban area with datalogger sites*

RESULTS

Mean, minimum, and maximum temperature data collected from August 2025 to February 2026 show marked variability across the monitored sites (Figure 2). The mean temperature differed by 0.7 ° C between the coldest location, a forested area (ID 16), and the warmest, a paved urban square (ID 6). Impervious surfaces such as concrete, asphalt, and paved squares consistently exhibited the highest temperatures.

Nevertheless, the absolute maximum daily temperature occurred in a suburban site (ID 15), likely due to its west-facing exposure and the absence of afternoon shading. The effect was intensified by the drying of a nearby water feature, which then behaved thermally like concrete.

The lowest recorded temperature, −12.72 °C, was measured at a composting facility (ID 1) on the city's western edge. Its proximity to a large water reservoir approximately 3 km away may have contributed to enhanced cooling. In contrast, a small city park (ID 7) and the adjacent paved square (ID 6) showed the lowest susceptibility to frost, indicating a relatively stable microclimate.

Thermal imaging revealed an average surface temperature of 39.7 °C, with concrete surfaces, paved areas, flat roofs, dry grass frequently exceeding 50 °C, reaching a maximum of 66.21 °C.

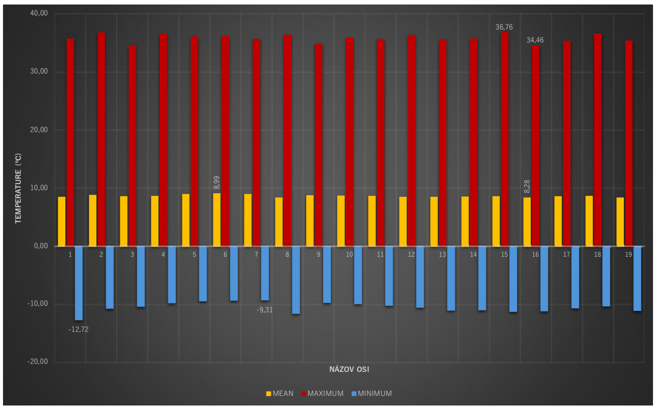

Figure 2. *Temperature data for the specified locations during the period from August 2025 to February 2026*

DISCUSSION AND CONCLUSIONS

Based on our research, we can conclude that urban and suburban sites showed clear thermal contrasts, with impervious surfaces producing the highest temperatures and forested or peripheral areas the lowest. Shading, orientation, and nearby water bodies strongly influenced extremes. Thermal imaging confirmed intense surface heating on built structures, while small green areas demonstrated greater microclimatic stability.

These findings provide a foundation for identifying suitable for pilot interventions, including green-space development, surface-material improvements, green-roof installation, and photovoltaic deployment.

REFERENCES

1. Žák, M. (2021). Urban climate in Central Europe. Charles University in Prague. Habilitation thesis. 36 p.
2. Shi, H., Xian, G., Auch, R., Gallo, K., & Zhou, Q. (2021). Urban Heat Island and Its Regional Impacts Using Remotely Sensed Thermal Data—A Review of Recent Developments and Methodology. Land, 10(8), 867. https://doi.org/10.3390/land10080867

ACKNOWLEDGEMENT: *This research is the result of the implementation of project no. 09I04-03-V02-00002, funded by the allocation of the European Recovery and Resilience Facility for Slovakia.*