



HEAT ISLANDS IN ZADAR AND RUGVICA

Ante Kuzmanić Medical School Zadar, Croatia

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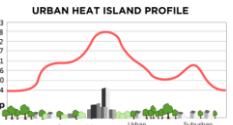
ABSTRACT

Since we have been actively participating for several years in the GLOBE campaign Urban Heat Island Effect by measuring surface temperatures of different surfaces at various locations, we wanted to investigate the differences in surface temperatures between asphalt and grass. We were also interested in the existence of heat islands, given that Zadar is an urban area and Rugvica is a rural area (with increasing spatial transformation manifested in the growing construction of residential buildings and the expansion of the industrial zone), and we were curious to see if there are differences in soil surface temperatures and air temperatures between rural and urban areas.

RESEARCH QUESTIONS

1. Is the difference between the maximum and minimum surface temperature on an asphalt surface greater in Zadar or in Rugvica?
2. Are the surface temperature values of the soil higher in an urban or rural area?
3. Is the air temperature higher in an urban or rural area?

INTRODUCTION



Urban Heat Islands is a phenomenon best described as the occurrence where certain geographic areas (e.g., a city) have higher air temperatures than surrounding areas (e.g., rural areas). Assuming that the Sun's heat and light reach all surfaces in the same way, the difference in temperature between urban and less developed rural areas is associated with the thermal capacity of surfaces in a given area.

Long-term cooperation between the Ante Kuzmanić Medical School in Zadar and Rugvica Elementary School prompted us to conduct joint research. The Ante Kuzmanić Medical School is located in coastal Croatia, while Rugvica Elementary School is in inland Croatia. We were also interested in the existence of heat islands since Zadar is an urban area, and Rugvica is a rural area (with an increasing transformation of space manifested in the growing construction of residential buildings and the expansion of the industrial zone).

RESEARCH METHODS

We compared measurements across different seasons (summer, winter, spring, autumn) to observe seasonal variations in surface temperatures, air temperatures, and the occurrence of the urban heat island effect. The measurement period was from March 1, 2024, to March 1, 2025. We conducted measurements on different surfaces (asphalt and grass) near schools.

We also compared air temperature data from GLOBE stations in Zadar and Rugvica and compared them with air temperature data from surrounding areas at GLOBE stations in Preko and Zagreb. Surface temperatures in Zadar and Rugvica were compared with surface temperatures in the surrounding areas of Preko and Zagreb. Surface temperature was measured using an infrared thermometer according to GLOBE protocols for surface temperature once a week, during the day, around solar noon.

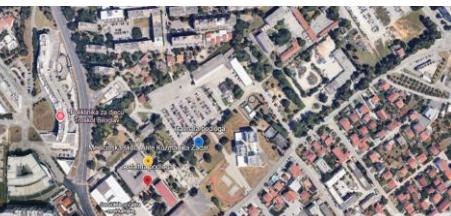


Figure 1. Display of selected measuring stations at the Ante Kuzmanić Medical School Zadar (Source: Google Earth, accessed February 28, 2025)



Figure 2. Display of selected measuring stations at Rugvica Elementary School (Source: Google Earth, accessed 28.2.2025.)

RESULTS

Measuring station	Maximum temperature of the grass surface	Minimum temperature of the grass surface	Maximum temperature of the asphalt surface	Minimum temperature of the asphalt surface
Rugvica	31.1 °C (5.6.)	-3.5 °C (29.11.)	41.4 °C (5.6.)	-10.1 °C (29.11.)
Zadar	36.9 °C (11.6.)	2.6 °C (15.1.)	47.4 °C (18.6.)	1.8 °C (15.1.)

Table 1 Display of maximum and minimum surface temperatures of asphalt and grass surfaces at measuring stations in Rugvica and Zadar

From the graphical representation of the data measured at the location of the Ante Kuzmanić Medical School, it can be observed that the surface temperature of the asphalt pavement is higher than the surface temperature of the grassy area. In the graphical representation of the data measured at the Rugvica Elementary School location, it was noted that the surface temperature of the grassy

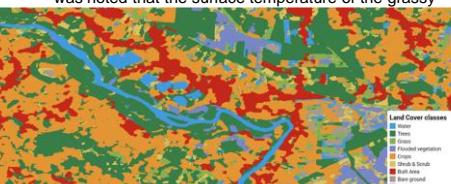


Figure 3. Satellite image of the land cover of the Rugvica municipality area (Source: Imagery Compare - Tool for Satellite Imagery Comparison of EarthMap.org.)



Figure 4. Satellite image of land cover in the area of the city of Zadar (Source: Imagery Compare - Tool for Satellite Imagery Comparison of EarthMap.org.)

By analyzing available satellite images of both locations, Zadar and Rugvica, it is evident that a higher level of urbanization, marked in red, prevails in the area of Zadar. Green areas, marked in green tones on the satellite images, prevail in the area of Rugvica.

DISCUSSION

- The amplitude of measured surface temperatures on the asphalt substrate is higher in Rugvica than in Zadar.
- In Rugvica, the surface temperature of the asphalt substrate was 51.5 °C, while in Zadar it was 45.6 °C, thus confirming our initial hypothesis.
- Average surface temperature values in Preko are higher than those measured in Zadar.
- Soil surface temperature values on the asphalt substrate are higher in the urban area, considering the city of Zadar, and surface temperature values on the grassy substrate are also higher in the urban area, Zadar, than in Rugvica.
- From the analysis of available air temperature data, we confirmed our hypothesis that air temperature will be higher in the urban area than in the rural area.

CONCLUSION

After the analysis and processing of the data and the conclusions made, the students created an action plan for the Green Week in April 2025 and presented this plan to the students of the school and the local community. In this way, our project has gained greater importance if we manage to reach the awareness of the local community in the right way. The students made posters and held workshops on surface temperature.

Workshop ("Heat in the community, how to measure



In order to mitigate the effects of UHI (Urban Heat Island), it is important to:

- orient buildings and their mutual relationships to form cooling corridors
- provide more detailed regulations on the typology, proportions, and shapes of buildings in the context of thermal insulation efficiency
- use materials with high energy efficiency as well as colors and types of materials to reduce UHI effects
- increase the share of green spaces and canopy coverage
- develop diverse public green areas and connect them into a green infrastructure system by prescribing special measures for areas with special restrictions.

LITERARY SOURCES

<https://mynasadata.larc.nasa.gov/basic-page/urban-heat-islands>
(accessed 8 January 2025)

https://mpgi.gov.hr/UserDocs/Images/dokumenti/NPOO/ZIKGP_NPOO/Metodologija_UHI.pdf (accessed 18 February 2025)

Duplančić Leder, T., Leder, N. & Hećimović, Ž. (2016). Determination of Land Surface Temperature in the Split Area Using Remote Sensing Method. Građevinar, 68 (11), 895-905.
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