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Urban effects on heatwave intensity and duration: a case study of the Vilnius city

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The aim of this paper is to determine the impact of the city on the intensity and duration of heat waves. The study was carried out in Vilnius city, Republic of Lithuania. Vilnius is the capital and largest city of Lithuania, with a population of 590 000 as of 2023. The area is 401 km^2 and the density is 1450/km^2. The central part of the city is located in the wide and deep valleys of the Neris and Vilnia rivers, while the other districts of the city are located on the surrounding hills and their slopes. The lowest point of the city is 97 m above sea level and the highest is 234 m.

An urban heat island (UHI) can amplify and prolong heat waves. This is important for the design and assessment of the energy performance of buildings in urban areas and the impact of heat waves on human health. The role of UHI will be even greater in the future due to climate change and possible global warming, as temperatures are likely to rise and the UHI will exacerbate them.

In this study, hourly air temperature data, as well as daily average, maximum, and minimum air temperature data were collected from Vilnius University automatic meteorological station (VU MS) located in the city centre, and automatic stations at Vilnius Airport (VA) in the suburbs during the summer seasons of 2022–2023.

In Lithuania, a heatwave is a natural meteorological phenomenon where the daily maximum air temperature reaches 30 °C or more for 3 consecutive days (or more). In total, 30% of the days in the summer of 2022 had a daily maximum air temperature above 30 °C in VU MS, while only 16% of the days in the suburban VA meteorological station reached this threshold. In the summer of 2023, 20 % and 7 % of such days were found, respectively. According to the VU MS data, 7 heat waves with a total duration of 32 days have been recorded for 2022–2023, while only 3 heat waves with a total duration of 11 days have been recorded in the suburban (VA) area. In the central part of the city (VU MS), the average daily maximum air temperature during heatwaves was 3.2 °C higher than in the suburban VA. It was also found that tropical nights (daily minimum air temperature of at least 20 °C) were more frequent in the city compared to the suburbs, and the amplitude of the daily air temperature increased during the heat waves.