Uncovering a Century of Change: Modeling Urban Groundwater Temperature Variability from 1893 to 2024.

Today's cities are facing increasing challenges as a result of both rapid urbanisation and ongoing climate change. One such phenomenon is Urban Heat Island (UHI) - consisting of higher temperatures in city centres than in surrounding areas. Although heat is most often referred to in the context of air temperature, a less well-known but equally important phenomenon is Subsurface Urban Heat Island (SubUHI), which refers to an increase in subsurface temperatures beneath urban areas. This phenomenon can be determined by ground temperature or groundwater temperature. Groundwater is not only a key source of drinking water supply, but also an important element of the natural and technical environment. Their temperature is important for water quality and the heat balance of cities. The increase in water temperature, observed in many cities around the world, may be the result of heat accumulation in the ground caused by human activity: dense development, the presence of technical infrastructure (e.g. heat pipelines) or limited surface retention through increasing areas covered by impermeable surfaces. Despite the growing importance of this problem, the SubUHI phenomenon is still relatively poorly recognised, especially under Polish climatic conditions. The results of groundwater temperature measurements to date show clear seasonal and spatial variations for the Wrocław area.

The project aims to investigate how groundwater temperature in Wrocław has changed over the last 130 years and how various factors such as urban development, land structure or climatic changes influence these changes. To this end, statistical and spatial analyses of groundwater temperature will be carried out covering three periods: 1893-1894 (data from Breslauer Statistik), 2004-2005 and 2022-2024 (measured data). Spatial analysis will be carried out for the collected data using spatial interpolation methods to create maps of the spatial distribution of temperatures over the different periods. This will allow an understanding of the long-term trends and dynamics of changes in the underground water environment in the context of the city's development. A database will be created taking into account potential factors influencing groundwater temperature. Based on this data, spatial regression models and models using machine learning methods will be developed. These will allow us to identify which factors are most responsible for changes in groundwater temperature and how SubUHI may develop in the future.

The project will provide an understanding of how urban processes and climate change affect groundwater resources, which may have implications for water resource management and urban planning. The results may also support the development of local climate change adaptation strategies.