Université de Neuchâtel
Centre d'hydrogéologie
et de géothermie (CHYN)

MSc in Hydrogeology and Geothermics

Thesis topic proposal 2024

Thermal dynamics of shallow groundwater in highly urbanized environments. A project in Japan

Context and objectives

Groundwater temperature is of crucial importance for water quality, ecosystems, and geothermal applications. However, understanding of shallow groundwater temperature in highly urbanized areas is so far limited. Latest research indicates potential hydrothermal impacts of changed land covers, disturbed groundwater flow processes, and heat or skink sources like buildings, subways or parking lots and geothermal energy instalations. Yet, a comprehensive understanding of the impacts and underlying mechanisms is hindered by the lack of reliable monitoring data in adequate spatial-temporal resolution. The University of Tokyo recently conducted preliminary monitoring of spring temperature in Koganei City. The data revealed complex spatio-temporal patterns, potentially influenced by both climatic forcing and land use. In this context the project aims at characterising and simulating thermal dynamics of shallow groundwater in highly urbanized environments to tackle the following questions: What is the spatio-temporal distribution of shallow groundwater temperature? To what extent can urbanization impact shallow groundwater thermal dynamics? What are the underlying governing mechanisms and major controlling factors? The outcomes are expected to enhance the fundamental understanding of urban hydrology science and contribute to fostering the sustainable management of groundwater resources in urban environments.

Methodology

The research approach will include (I) On-site monitoring, (II) Water chemistry analysis and (III) Numerical hydrogeological modeling. New g and existing boreholes will be equiped with temperature and groundwater level loggers. Flow will be measured in five rainwater infiltration wells. Groundwater and spring samples will be collected to measure standard physico-chemical parameter, water stable isotopesand sulfur hexafluoride (SF6) to identify ground water flux and quantify travel time. To simulate the coupled processes of surface-subsurface flow and heat transfer, conceptual models will be developed using the code HGS. The results can provide a quantitative interpretation of the monitoring data and detailed investigations of the underlying mechanisms concerning both atmospheric conditions and urbanization. A stay at the University of Tokyo in the group of Prof. Liu is foreseen for this project. It is expected that the student writes a grant to the “Fonds de Donation” to cover the travel cost: https://www.unine.ch/curs/home/fonds-des-donations-de-luniversi.html.

Supervision and collaboration

The project will be supervised by Prof Philip Brunner and Benoît Valley at Université de Neuchâtel and Dr. Jiaqi Liu at The University of Tokyo.

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Spring discharge at Koganei City in Tokyo, Japan.