Université de Neuchâtel
Centre d'hydrogéologie
et géothermie

MSc in Hydrogeology and Geothermics

Thesis topic proposal 2026

Project “Smart Drain”: Performance Evaluation of a Smart Drainage Control Model in a Highly Instrumented Agricultural Catchment

Context and objectives

Smart drainage systems have recently been deployed in an agricultural catchment to enable active control of the local water table. By adjusting drain operation in response to field conditions, the system aims to optimize soil moisture, reduce nutrient leaching, and improve crop resilience under variable weather. A real-time modeling framework is currently being developed using HydroGeoSphere, combined with a data-assimilation workflow that integrates continuous measurements from a dense network of soil-moisture sensors and groundwater monitoring wells. The overarching objective of the master thesis is to evaluate the reliability and predictive skill of this real-time model, particularly when it is used to simulate operational strategies under meteorological forecasts.

Methodology

The thesis will involve the systematic integration of field observations into the modeling workflow. A protocol will be developed to test different drain-operation scenarios, incorporating forecasted weather conditions and comparing model outputs against independent validation datasets. In addition, targeted field experiments—where the smart drains are deliberately operated under controlled conditions—may be conducted to generate high-quality datasets for model calibration and validation. The student will run a series of controlled simulations, quantify model performance using statistical metrics, and identify conditions under which predictions are robust or uncertain.

The project includes a strong field component: verifying sensor functionality, collecting supplementary measurements, and documenting hydrological responses to drain operations. On the technical side, the work requires proficiency with state-of-the-art modeling tools, data-assimilation techniques, and environmental data processing. Together, these components will allow the student to produce a rigorous assessment of model validity and provide recommendations for improving real-time water-table management using smart drains. There is a strong and direct connection to the Project “Agricultural CO2 emission” as both projects use the same agricultural plot.

Supervision and collaboration

Dr. Hugo Delottier, Philip Brunner, Field aspects of the projects will be carried out in collaboration with Dr. Ursina Morgenthaler, a postdoc in the group of Daniel Hunkeler. The project will be carried out in close collaboration with the farmer and the Seeland farmer association, Proagricultura Seeland

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