Université de Neuchâtel
Centre d'hydrogéologie et géothermie

MSc in Hydrogeology and Geothermics
Thesis topic proposal 2026

Mud-cracks formation and their hydrological impacts in degraded wetlands

Context and objectives

Wetland degradation and drying can strongly modify the structure and hydrological functioning of near-surface soils. In degraded or seasonally dried wetlands, the formation of "**mud-cracks**" and shallow surface fractures may create preferential pathways for infiltration, alter surface runoff generation, and modify the spatial redistribution of rainwater. These processes have important consequences for peatland and **wetland restoration**, yet the conditions controlling the onset of surface cracking in bare soils remain poorly constrained, particularly in comparison with more stable surfaces protected by continuous vegetation cover.

The proposed project aims to investigate the critical conditions leading to the development of micro-scale surface fractures in degraded wetlands in Switzerland, with a focus on a monitored field site in the Canton of Lucerne. The study will explore how soil-water stress, surface desiccation, and vegetation cover influence crack initiation and propagation, and how these fractures affect subsequent hydrological behavior, including runoff generation and rainwater percolation. Particular attention will be paid to the contrast between bare, degraded soil surfaces and more homogeneous vegetated “green carpet” conditions. The project will combine field observations, drone-based imaging, and tracer tests with 2D–3D numerical simulations to better understand the formation and hydrological consequences of near-surface cracking.

Methodology

The project will begin with field observations at the monitored wetland site (Balmoos) in the Canton of Lucerne, where surface conditions, vegetation cover, and crack patterns will be documented using drone imaging and targeted field surveys. Such surface features will be contrasted with local soil moisture observations and historical water table level measurements to target critical values for cracking formation. These observations can be eventually complemented by tracer tests designed to evaluate whether surface fractures enhance preferential infiltration or simply modify local runoff pathways. A second component of the work will focus on identifying the critical conditions associated with crack formation, including drying state, soil-water stress, and vegetation characteristics that may either promote or inhibit fracture onset.

The field results will then be used to guide the development of 2D–3D numerical simulations of near-surface stress, fracture development, and hydrological response. The modeling approach will be guided by prior work on shrinkage-driven fracture networks in drying porous materials, showing that crack spacing and polygonal organization depend on peat layer thickness, drying-front dynamics, and repeated wetting–drying cycling. The combined analysis will aim to quantify how surface cracking changes infiltration and runoff behavior relative to non-cracked, vegetated surfaces, and to identify the key controls governing the emergence and hydrological impact of micro-fractures in degraded wetlands.

Supervision and collaboration

The project will be supervised by Dr. F. Miele (CHYN, UniNe) and in collaboration with Prof. C. Roques (CHYN, UniNe). **Contact :** filippo.miele@epfl.ch