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Investigating land use effects on soil hydrology in alpine ecosystems by stable isotopes

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Soils in mountain areas are an important factor for hydrological ecosystem services of a region (e.g. drinking water reservoirs and flood prevention). Changes in land use are currently affecting mountain soils inducing a change not only in biogeochemical cycles, slope stability, vegetation productivity, ecosystem biodiversity and nutrient production but also in water budgets and flow paths. The main changes in land use in the Swiss Alps are reduced farming activities, which have led to massive shrub encroachment and forest expansion into formerly open habitats, particularly at higher elevations. These land use changes affect the hydrology of soils and adjacent lowlands. In our test region, the Ursern Valley in the Swiss Central Alps, we assess the status and current change of vegetation cover, its influence on soil characteristics, and their combined effects on the soil water balance and soil integrity. Water balance might be affected by green alder shrubs with increased interception, evapotranspiration and infiltration compared to grasslands. Further, green alders can be expected to alter soil physical and chemical properties.

In four micro catchments (< 1 km^2) with different percentage of green alder cover we investigate how the expansion of green alder affects the soil hydrology. We directly compare soil hydrological parameters of green alder and grass land sites. Investigated soil hydrological parameters include volumetric soil water content to estimate water infiltration, surface flow and soil erosion, soil bulk density, and water residence times in soils. The latter will be studied by a stable isotope approach (^{18}O and ^{2}H in water). With weekly stable isotope data of precipitation and runoff we will model water residence times. In addition, we applied a soil water stable isotope sampling along a transect of a grass land site to study water flow processes.

The stable isotopes of soil water confirmed our findings from the volumetric soil water content data that water infiltration rates are rather high. Moreover, we could infer from the soil water depth profiles that vertical infiltration processes are dominating even at high slope angles. Lateral flow processes at lower slope angles were observed to a smaller degree. Our results from the first year of precipitation and stream water stable isotope sampling show that, the micro catchments have high water residence times despite their small size. The latter might point to deep flow paths with the infiltrating precipitation percolating through deeper carbonate rich rock layers which underlie the gneiss parent material. Our stream water pH measurements in these micro catchment (pH was 7-8) support this conclusion.