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Linking soil water and solutes fluxes to soil properties and vegetation types: insights from a case-study in the high tropical Andes of Ecuador

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The high tropical Andes ecosystem, known as páramo, provides important hydrological services to densely populated areas in the Andean region. In order to manage these services sustainably, it is crucial to understand the biotic and abiotic processes that control both water quality and fluxes. Recent research in the páramo highlights a knowledge gap regarding the role played by soil-vegetation interactions in controlling soil-water processes and resulting water and solute fluxes.

Here, we determine the hydrological and geochemical fluxes in four soil profiles in the páramo of the Antisana's water conservation area in northern Ecuador. Water fluxes were measured biweekly with field fluxmeters in the hydrological year Apr/2019- Mar/2020 under two contrasting vegetation types: tussock-like grass (TU) and cushion-forming plants (CU). Soil solution was collected in parallel with wick samplers and suction caps for assessing the concentrations of dissolved cations, anions and organic carbon (DOC). In addition, soil moisture was measured continuously in the upper meter of the soil profile, i.e. first three horizons (A, 2A and 2BC), using water content reflectometers. The vertical water flux in the upper meter of each soil profile was simulated using the 1D HYDRUS model. We carried out a Sobol analysis to identify sensitive soil hydraulic parameters. We then derived water fluxes by inverse modeling, based on the measured soil moisture. We validated the calculated water fluxes using the fluxmeter data. Solute fluxes were estimated by combining the water fluxes and the soil solution compositions.

Our preliminary results suggest that water fluxes and DOC concentration vary under different vegetation types. The fluxmeter data from the 2A horizon indicates that the cumulative water flux under TU (2.8 - 5.7 l) was larger than under CU (0.8 - 1.1 l) during the dry season (Aug-Sep and Dec-Jan). However, the opposite trend was observed in the wet season for maximum water fluxes. Moreover, the DOC concentration in the uppermost horizon was higher under CU (47.3 ± 2.2 mg l⁻¹)

than under TU ($3.1 \pm 0.2 \text{ mg l}^{-1}$) vegetation during the monitoring period. We associate the water and solute responses under different vegetation types to the contrasting soil hydro-physical and chemical properties (e.g., saturated hydraulic conductivity and organic carbon content) in the uppermost soil horizon. Our study illustrates the existence of a spatial association between vegetation types, water fluxes and solute concentrations in Antisana's water conservation area. By modelling the hydrological balance of the upper meter of the soil mantle, the water and solute fluxes will be estimated for soils with different vegetation cover.