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Effect of soil-plant interactions on nutrient availability and supply in a tropical Andean ecosystem

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Plants play a key role in absorbing nutrients and water through their roots, and modulate the biogeochemical cycles of terrestrial ecosystems. Nutrient uptake mechanisms of water and nutrient by plants depend on climatic and edaphic conditions, as well as of their root systems. Soil solution is the medium in which abiotic and biotic processes exchange nutrients, and nutrient concentrations vary with the abundance of reactive minerals and fluid residence times. High-altitude grassland ecosystems of the tropical Andes are particularly interesting to study the relationship between vegetation communities, soil hydrology and mineral nutrient availability. In páramo ecosystems, forest, tussock grasses and cushion plants co-occur across the landscape. In the nutrient-depleted nonallophanic Andosols, the plant rooting depth varies with drainage and soil moisture conditions. Vegetation composition is a relevant indicator of rock-derived nutrient availability in soil solutions. Significant variations in the soil solute chemistry revealed patterns in plant available nutrients that were not mimicking the distribution of total rock-derived nutrients nor the exchangeable nutrient pool, but clearly resulted from strong biocycling of cations and removal of nutrients from the soil by plant uptake or deep leaching. Our findings highlight the importance of vegetation communities, soil hydrological condition, and the bioavailability of mineral nutrients to trigger rapid and complex changes in the biogeochemistry of soil waters. Moreover, the findings have important implications for future management of Andean ecosystems where vegetation type distributions are dynamically changing as a result of warming temperatures and anthropogenic disturbances. Such alterations may not only lead to changes in soil hydrology and solute geochemistry but also to complex changes in weathering rates and solute export downstream with effects on nutrient availability in Andean rivers and high-mountain lakes.