

Impacts of climate change on the stability and resiliency of Páramo Peatlands

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Abstract

The Andean *páramo*, a tropical alpine ecosystem situated between the tree line and snow line, contains the greatest global area of tropical mountain peatlands. It has a year-round wet season that supports peatlands within a matrix of grasslands, woodlands, and unique plant life forms. Limited studies on *páramo* peatlands point to their disproportionate carbon [C] storage and hydrologic regulation functions relative to their spatial extent. Recent research also indicates that climate change is driving more pronounced wetting-drying cycles, an enhanced dry season, and more variable precipitation inputs leading to increased drying that will dramatically change C-water balances in *páramo* peatlands. These impacts may be further exacerbated by a long history of land use change in the *páramo*, a trend predicted to continue. Unique plant functional types characteristic of *páramo* peatlands is crucial yet poorly understood biotic drivers that may affect C-water responses to a changing precipitation regime. Despite the local and global ecohydrological and socioeconomic importance of tropical mountain peatlands, most understanding of climate change impacts on peatland ecohydrology comes from northern lowland peatlands. As a result, we have limited ability to parameterize and validate models that predict climate change impacts on *páramo* peatland C processing and hydrologic regulation, and to strategically manage critical *páramo* ecosystem services. Numerous studies warn of the exceptionally high vulnerability of *páramos* to climate and land use change and the significant consequences for coupled C-water cycles. The C stored in those soils (and vegetation) is vulnerable to predicted lower water inputs leading to changes in the composition of peatland microbial populations responsible for producing carbon dioxide [CO₂] and methane [CH₄]. As water tables lower from predicted increases in drought or land use change, peat soils become more oxygenated, encouraging the production of CO₂ over CH₄ that leads to *páramo* ecosystems becoming sources of C to the atmosphere instead of their role as historic sinks for atmospherically derived C, exacerbating future climate change. In addition, plant functional groups play an important role in C sequestration and are also vulnerable to change with predicted drying which feeds back to the overall ecosystem C balance. We need to better understand how *páramos* respond to less water inputs and how that affects plant communities and overall ecosystem C balance.

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However, how the amount, duration, and periodicity of rainfall and drainage in *páramo* peatlands impacts the water table, soils, and subsequent C fluxes—and the role of plant functional types unique to *páramo* peatlands in controlling these processes—has not been studied, especially in light of ongoing and future changes in climate. Planned studies in southern Ecuador associated with the University of Cuenca and the Zhurucay Ecohydrological Observatory will address knowledge gaps quantifying the unique ecohydrological properties of tropical mountain peatland ecosystems, determine their sensitivity to increases in the frequency and duration of drying, and model how changing precipitation regimes and groundwater levels interact with changing plant functional groups, with long-term impacts on greenhouse gas dynamics, C sequestration, and watershed hydrology.

Keywords: Carbon storage, Hydrologic regulation, Greenhouse gases.