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Assessing the Impact of Land Use on peat degradation in alpine bogs

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Peatlands play a crucial role as reservoirs of soil organic carbon and nitrogen, storing twice as much carbon as all the world's forests. However, land-use changes such as drainage for agriculture or forestry have led to more than 50% of Europe's peatlands being classed as degraded, with Austria facing an even higher disturbance rate at 90%. This degradation is causing serious environmental consequences, notably increased greenhouse gas emissions and nutrient leaching that contaminates the surrounding groundwater. Despite this, the impact of land-use on peatlands is still not well understood.

To evaluate the influence of land use on peat decomposition and nitrogen concentration over depth, we investigated physical and chemical properties, as well as dissolved carbon and nitrogen forms of three different valley bogs with a common origin, but under different land use management. Our study sites included: a pristine bog, a heavily drained afforested spruce stand, and an intensive meadow, located in the Enns River Valley of the Eastern Alps, Austria. We divided 1 m peat cores into separate 10 cm sections and analysed these peat samples for bulk density, loss on ignition, water content, carbon and nitrogen contents and ratios, stable carbon and nitrogen isotope signatures and four humification indices (based on Fourier transform infrared spectroscopy) and dissolved organic carbon, dissolved total nitrogen, ammonium and nitrate.

The afforestation site showed a significantly higher degree of peat decomposition across its vertical profile, possibly owing to higher levels of drainage. The similar levels of dissolved organic carbon and total nitrogen, but higher concentrations of ammonium and nitrate in the 0-50 cm layer, compared to the pristine bog, suggests that spruce rhizosphere activity and increased aerobic conditions due to drainage may promote nitrogen mineralisation and nitrification. Conversely, the intensive meadow site showed the highest degree of peat decomposition in the top 30 cm, with the deeper layers resembling the pristine bog. The intensive meadow site also revealed comparatively higher dissolved organic carbon, total nitrogen and organic nitrogen, but similar ammonium and nitrate as the pristine bog. This was probably due to the combined influence of agricultural nutrient inputs, plant uptake and leaching. Principal component analysis of the measured parameters for the three sites clearly indicate differences between the study sites, and between the surface and deeper layers, with indicators of peat decomposition and nutrient status being the main factors differentiating the study sites .

Our results facilitate an improved understanding of how afforestation and intensive meadow

management can contribute to peat degradation, and highlight potential environmental consequences of these practices on drained peatlands, particularly with respect to nutrient leaching into deeper peat layers (below 30 cm). Furthermore, this research emphasizes the critical need for sustainable land management practices in mitigating peatland degradation, particularly in managing drainage and agricultural activities, to preserve the ecological balance and prevent adverse effects such as further degradation and groundwater contamination.