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Peat decomposition indicators of two contrasting peat bogs in the Eastern Alps, Austria

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Worldwide ~612 Pg of carbon (C) is stored in peat, of which ~270 to 370 Pg C have been removed from the atmosphere by peat growth since the last glacial period. Since C in peatlands is labile and sensitive to disturbances, peatlands entail the potential to release high amounts of C in the course of land use changes and proceeding global warming. Therefore, adequate peat decomposition indicators (PDI) are necessary to assess the peatland degradation status and potential C release of peatlands.

In order to assess the degradation status of Alpine peat bogs and to evaluate the PDI, we compare PDI in two Alpine peat bogs with contrasting land-use histories located in the Enns valley, Austria. We evaluate the conventional PDI loss on ignition, bulk density, C:N ratios, water table depths (WTD) and the recently introduced PDI stable carbon isotope ratios (δ^{13}C) and stable nitrogen isotope ratios (δ^{15}N) at nine study sites.

We detected significant differences in PDI between the two bogs and between the study sites, which vary in WTD and degree of decomposition. Moreover, we demonstrate strong relationships and similar depth profiles of the variables. Loss on ignition of strongly degraded sites decrease from the acrotelm (94.77%) to the catotelm (80.02%), but remain stable at less degraded sites (~97.76%). Bulk density generally increases with depth, featuring lowest values in the acrotelm of the central bog area (0.05 g cm^{-3}) and highest values in the catotelm of the former peat cutting areas (0.18 g cm^{-3}). C:N ratios exhibit large variations at most sites, but demonstrate differences in the degree of decomposition. Regarding the δ^{13}C and δ^{15}N, we observed an increase in the uppermost layers down to depths of -24 to -42 cm at all study sites. In the catotelm, δ^{13}C are significantly lower in strongly decomposed peat (-27.44 $\pm$0.37‰) in contrast to the less degraded sites (-26.09 $\pm$0.59‰). δ^{15}N are significantly higher at strongly degraded sites in both, acrotelm (-0.75 $\pm$2.11‰) and catotelm (-0.45 $\pm$0.84‰) compared to the slightly degraded sites (-4.89 $\pm$1.91‰ and -4.37 $\pm$1.10‰ respectively). C isotope discrimination in plants causes a depletion in δ^{13}C of the residual litter, as ^{13}C is more frequent in polysaccharides, representing the easier decomposable component of the litter. In contrast, aerobic decomposers tend to preferably use ^{12}C and during respiration, resulting in a relative enrichment of ^{13}C in the residual organic matter. Accordingly, the increase of δ^{13}C in the acrotelm in strong decayed peat are assigned to the respiration process, whereas the preferential removal of polysaccharides is the dominating fractionation mechanism in the catotelm of the strongly degraded sites.

We conclude that the PDI are partially comparable and that it is possible to assess the degradation status of the respective sites. The use of δ^{15}N and δ^{13}C as PDI is implementable, but with limitations: slight differences in the degree of peat decomposition could not be revealed and initial ratios of different plant species and atmospheric ratios during peat formation may differ widely.