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Stable isotopes, radiocarbon signature and C loss as an indicator for soil degradation in a drained peatland, northern Germany

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Peatlands are an important component of the global carbon cycle. Even though they cover only about 3% of the global land area, they store approximately 600 Pg carbon (C) in their soils. Drainage for agriculture use, for example as grassland, induces oxic conditions in the upper part of a peat profile and increases the carbon dioxide emissions. Peatlands thus change from a carbon sink in pristine status to a carbon source under drainage and land use intensification.

Detailed peat profile analyses in a drained peatland under grassland use in northern Germany were used to study the influence of drainage and land use management on stable isotope depth profiles and to calculate retrograde C losses by the ash method. Peat profiles (n=3) were taken from one semi-natural bog as reference and two adjacent drained peatlands located at the former peat bog which has been used as grassland (extensive, intensive use) for the last decades. The peatland drainage started at the beginning of the 20^{th} century and land use was intensified in the middle of the 20^{th} century. The semi-natural peatland is unmanaged, the extensive grassland is neither fertilized nor manured and only cut once per year and the intensive grassland is cut 4-5 times per year and fertilized with mineral fertilizer and manure.

All grassland peat cores show a clear ash peak in the upper most centimetre of the profile indicating an accumulation of ash caused by the oxidation of the organic material. Calculated carbon losses since the drainage of the peatland are 540 ($\pm$156) and 290 ($\pm$36) t C ha^{-1}for the intensive and extensive used grassland, respectively. The constant background ash values from the lower profile were taken as reference values, because even the semi-natural site accumulated ash in the topsoil and has lost 144 ($\pm$98) t C ha^{-1} based on this method. A likely drainage influence by the surrounding area is also reflected in the δ^{13}C values of the semi-natural site with an increase of the δ^{13}C values with depth in the upper part which is also displayed in the drained sites. Furthermore, the δ^{15}N values show clear difference between the sites with low δ^{15}N at the semi-natural site, slightly negative values at extensive and positive values at the intensive grassland site. The latter is most likely caused by the application of fertilizer and manure as well as the advanced decomposition of peat material in the upper part, which is supported by the lower C/N ratios in this depth. Radiocarbon pMC values confirmed stronger peat decay under grassland compared to the semi-natural situation. These were 90.2 ($\pm$2.6) and 91.6 ($\pm$2.3) pMC in the extensive and intensive grassland (8-14 cm depth), referring to calibrated radiocarbon ages of around 1000 – 1500 years BP whereas the corresponding pMC value for the semi natural site (112.8 $\pm$4.0) indicated dominance of organic matter fixed during the second half of the last century.