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Long-term macronutrient stoichiometry of UK ombrotrophic peatlands

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Ombrotrophic peatlands across northern latitudes represent a globally-important store for carbon (C), nitrogen (N) and phosphorus (P) through the Holocene. A key characteristic of ombrotrophic bogs is that N, P and other elements vital to their biogeochemical functioning are almost exclusively supplied by hydrological and biological inputs from the atmosphere. While different mechanisms regulating the atmospheric supply of N and P and their limiting effects on bog productivity have been widely studied, limited attention has been paid to the long-term patterns of, and controls on, macronutrient accumulation, cycling and stoichiometry in ombrotrophic peatlands. Indeed there is a dearth of C, N and P stoichiometric data from the UK despite decades of peatland research.

Using data from 15 sites, we report the first estimates of millennial-scale macronutrient concentrations and accumulation rates in UK ombrotrophic peats. Carbon, nitrogen and phosphorus concentrations were measured on cores from five ombrotrophic blanket mires, spanning 4000-10000 years to present, and integrated with existing nutrient profiles from ten Scottish sites. Long-term C, N and P concentrations for the UK are 55.1, 1.55 and 0.037 wt%, similar to the few existing northern and tropical comparable sites worldwide. The uppermost peat (0 - 0.2 m) is more enriched in P and N (51.0, 1.86, and 0.070 wt%), while the deeper peat (0.5 – 1.25 m) is more depleted (56.6, 1.39, and 0.028 wt%). Long-term average (whole core) accumulation rates of carbon, nitrogen and phosphorus are 25.3±2.2 gC m^{-2} yr^{-1}, 0.70±0.09 gN m^{-2} yr^{-1} and 0.018±0.004 gP m^{-2} yr^{-1}, again similar to values reported elsewhere in the world.

A number of significant findings can be drawn from our results: i) N and P concentrations in ombrotrophic peat are strongly associated, such that a regression model of N concentration on P concentration and mean annual precipitation, based on global meta data for surface peat samples, can explain 54% of variance in N concentration in the UK peat profiles; ii) the patterns of long-term macronutrient stoichiometry and accumulation between sites across the world are strikingly similar similarity, such that peats may reasonably be treated as a single entity in global nutrient budget calculations. Our UK results corroborate published estimates of N storage in northern boreal peatlands through the Holocene as ranging between 8 and 17 Pg N; and iii) higher N and P concentrations in the surface peat is a distinctive feature that remains unconvincingly explained, raising the possibility that enhanced atmospheric supply of nutrients may impact C uptake and burial by peat bogs and meriting particular focus from the research community.