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Developing palaeolimnological records of organic content (DOC and POC) using the UK Acid Water Monitoring Network sites

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Monitoring programmes have shown increases in concentrations of dissolved organic matter (DOM) in the surface waters of northern and central Europe (Monteith et al. 2007), and negative impacts of the browning of river waters have been reported for fish populations (Jonsson et al. 2012; Ranaker et al. 2012) and for ecosystem services such as water treatment (Tuvendal and Elmqvist 2011). Still the exact causes of the recent browning remain uncertain, the main contenders being climate change (Evans et al. 2005) and reduced ionic strength in surface water resulting from declines in anthropogenic sulphur and sea salt deposition (Monteith et al. 2007). There is a need to better understand the pattern, drivers and trajectory of these increases in DOC and POC in both recent and longer-term (Holocene) contexts to improve the understanding of carbon cycling within lakes and their catchments.

In Britain there are some ideal sites for testing whether these trends are preserved and developing methods for reconstructing organic fluxes from lake sedimentary archives. There is a suite of lakes distributed across the country, the UK Acid Waters Monitoring Network (UKAWMN) sites, which have been monitored monthly for dissolved organic carbon and other aqueous species since 1988. These 12 lakes have well studied recent and in some case whole Holocene sediment records. Here four of those lakes (Grannoch, Chon, Scoat Tarn and Cwm Mynach) are revisited, with sampling focused on the sediment-water interface and very recent sediments (approx.150 years). At Scoat Tarn (approx. 1000 years) and Llyn Mynach (11.5k years) longer records have been obtained to assess equivalent patterns through the Holocene.

Analyses of the gravity cores have focused on measuring and characterising the organic content for comparison with recorded surface water DOC measurements (UKAWMN). Data from pyrolysis measurements (TGA/DSC) in an N atmosphere show that the mass loss between 330-415°C correlates well with observed trends in DOC of surface waters. Analysis of these cores and various calibration materials (e.g. peat) suggests plant tissue undergoes pyrolysis at lower temperatures, and though humic substances can be generated in the lake this thermal phase may be a proxy record for catchment derived DOC. NIR and FTIR spectrometry data further characterise this organic phase, identify spectral structures that also correlate with monitored DOC. Together the pyrolysis, NIR, FTIR and XRF geochemistry (e.g. Fe/Mn, Si/Al ratios) data show also information on lake productivity, biogenic silica and mass accumulation rates. To explore the longer timescale equivalent proxy records have been trialled at Llyn Cwm Mynach and show possible phases of elevated DOC fluxes from catchment soils during the Holocene.

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