Transfer of organic matter through a peatland system – from terrestrial to aquatic systems

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1. Introduction

- Peatlands are important terrestrial carbon stores, with 500 ± 100 Gt C in northern peatlands.
- Stoichiometric approaches have been used to understand carbon cycling through Moor House, an upland blanket bog in the UK.[1,2,3]
- DOM in peatland streams highly oxidised – how does this arise?
- This study assesses how organic matter changes from terrestrial to aquatic systems through a peatland system.

2. Methods

- Study site Moor House National Nature Reserve, Upper Teesdale, UK.
- Upland blanket bog – ombrotrophic peatland.
- Study focused on zero order stream (CHS - Figure 1).

- Samples of:
  - Vegetation
  - Litter
  - Peat (2x 1m cores)
  - Dissolved organic matter (DOM)
  - Particulate organic matter (POM)
  - DOM & POM stream & soil water
- Analysed for CHNOS content

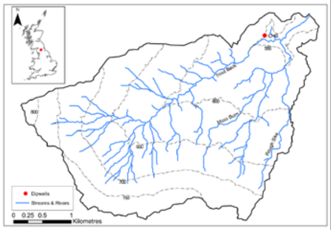

Figure 1. Map of Moor House National Nature Reserve. Contours show altitude (m).

Figure 2. Cottage Hill Sike – stream water DOM/POM sample site.

- CHS DOM/POM (Figure 2).
- Shallow & deep soil pore water (SPW) DOM/POM from gully wall (Figure 3).
- Bulk SPW from total volume of gully interfluve dipwells.

Figure 3. Sampling soil pore water from shallow and deep dipwells in a gully wall.

3. Dissolved organic matter (DOM)

- Elemental composition & carbon oxidation state of DOM sources (Figure 4).
- Shallow, deep & bulk soil pore water; Cottage Hill Sike (stream water).
- Compared using analysis of variance (ANOVA).

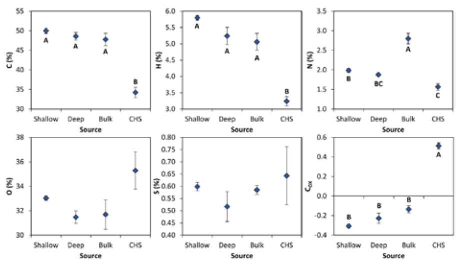

Figure 4. Mean ± standard error (where visible) elemental composition & carbon oxidation state (C_{OX}). ANOVA significant differences denoted where letters not shared between DOM source types.

4. Organic matter composition of peat

- Carbon fluctuates in near-surface but increases down core.
- No significant changes down-core for HNOS.
- Median stoichiometry:
  - Peat: $C_{359}H_{509}N_8O_{199}S$
  - SPW DOM: $C_{227}H_{305}N_8O_{111}S$
  - CHS DOM: $C_{176}H_{206}N_6O_{143}S$

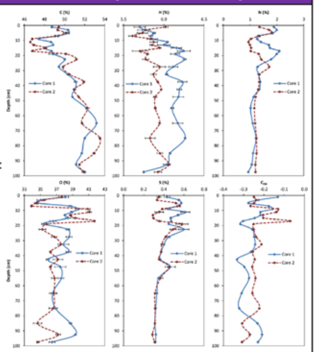

Figure 5. Peat core CHNOS content (mean ± standard error for triplicate analysis of CHNO and duplicate S analysis) and carbon oxidation state (C_{OX}).

5. Transition of organic matter

- Principal components analysis (PCA) using CHNOS, carbon oxidation state (C_{OX}), oxidative ratio (OR) & degree of unsaturation (unsat).
- Figure 6 shows different end-members based on loadings of particular variables (strong + or – PC scores in Table 1).

Table 1. First four principal components & variance explained. Strong loadings in bold.

Variable	PC1	PC2	PC3	PC4
N	0.11	0.13	**-0.76**	-0.24
C	**0.47**	0.12	0.28	-0.15
H	**0.50**	-0.11	-0.04	0.11
O	0.08	**-0.71**	0.28	-0.14
S	-0.28	0.34	0.18	**0.63**
C_{OX}	**-0.46**	-0.13	-0.20	-0.30
OR	**0.47**	0.19	-0.18	0.18
Unsat	-0.02	**0.53**	0.39	**-0.61**
Eigenvalue	3.86	1.55	1.41	0.90
Proportion	0.48	0.19	0.18	0.11
Cumulative	0.48	0.68	0.85	0.96

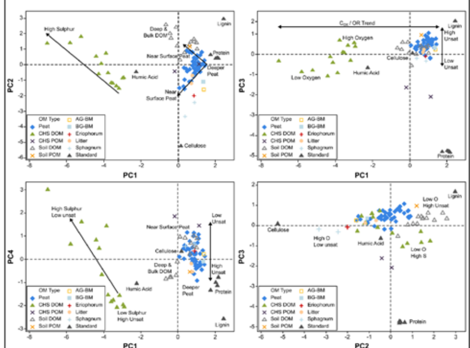

Figure 6. Scatterplots of principal components by organic matter source type. Variables for each PC given in Table 3. AG-BM = above ground biomass; BG-BM = below ground biomass.

- Soil pore water DOM evolved from near-surface peat.
- Stream water DOM (CHS) distinct – positive C_{OX} shows more oxidised than other organic matter types.

6. Conclusions

- Stream water DOM is distinct from both terrestrial organic matter and soil water DOM, with significant decreases in CHN content.
- Future analyses include CNS isotopes, FTIR, radiocarbon dating.
- New samples collected at 10 cm depth in peat and surface runoff to further analyse transfer of DOM and POM from soil to stream.

References: 1. Worrall, F. et al. (2013) *The multi-annual nitrogen budget of a peat-covered catchment – changing from sink to source?*. STOTEN. Volume 433: 178-188. 2. Worrall, F. et al. (2016) *The total phosphorus budget of a peat-covered catchment*. JGR: Biogeosciences. Volume 121: 1814-1828. 3. Worrall, F. et al. (2017) *The flux of organic matter through a peatland ecosystem: the role of cellulose, lignin and their control of the ecosystem oxidation state*. JGR: Biogeosciences. Volume 122: 1655-1671.