Dissolved organic carbon (DOC) release following drought: influence of DOC source and drought severity on drinking water treatment

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1. Introduction and research questions

Changing drought frequency may alter carbon storage in peatlands. The resulting DOC flux to surface waters must be removed, normally by coagulation/flocculation, to achieve potable water standards.

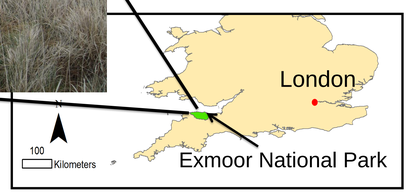
A combination of climate change, nitrogen deposition and management practices may increase the prevalence of grassland species in peatlands. Grassland species have adapted different growth strategies and nutrient cycling and may therefore alter carbon stability in peat.

A laboratory simulation was performed on DOC production under control and three severities of drought for typical upland DOC sources (*Calluna vulgaris*, *Juncus Effusus*, *Molinia caerulea*, *Sphagnum Spp.* and a peat soil). *Sphagnum* is currently promoted through catchment management.

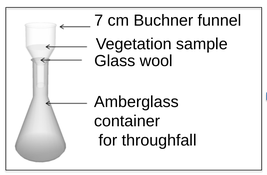
Is source or climatic conditions more important for DOC production?
Are peatland management practices good for mitigation?
Can current coagulation techniques cope with future conditions?

2. Site, setup and conditions

Exmoor National Park, UK was chosen to collect the vegetation as it has been identified as a marginal peatland at risk from climate change and serves as a drinking water catchment.



GIS data: Natural England



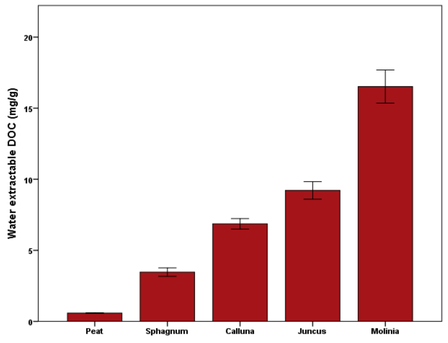
Into climate control chamber

Six week incubation at these conditions

Drought severity based on percentiles of Met Office long-term records for rainfall in the area.

Drought Treatment	Monthly rainfall total (mm)
Control (50th percentile)	79.0
Mild (25th percentile)	51.5
Moderate (10th percentile)	34.7
Severe (5th percentile)	23.3

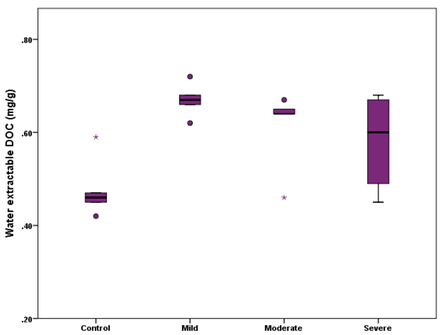
Result 1. DOC production from grassland vs. upland sources



ANOVA with Tukey post-hoc shows DOC production is in the order: *Molinia* > *Juncus*> *Calluna*> *Sphagnum*> peat soil.

This result validates catchment management programmes to encourage *Sphagnum* over vascular plants and to preserve peat soils.

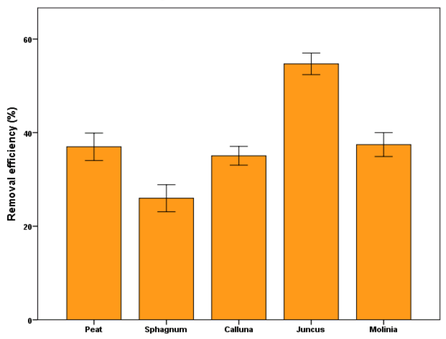
Result 2. Drought causes greater DOC flux from peat- 'enzymatic latch' mechanism



ANOVA (Holm-Šidák correction) suggests increased DOC flux from peat during drought ($p=0.01$).

Increased oxygenation engaging the 'enzymatic latch' mechanism could explain this result.

Result 3. Coagulation removal efficiency with ferric sulphate



DOC from *Juncus* was the easiest to remove during jar testing whereas *Sphagnum* was the hardest. All other sources were the same (Tukey test).

No drought effects were found at the 0.05 level suggesting source is more important than climate for DOC treatability.

Impact 1. Transition to grassland species in peatlands may increase DOC flux. Catchment management to support *Sphagnum* is justified for drinking water provision.

Sphagnum bog → N deposition / droughts → *Molinia* grassland → Greater DOC flux

Impact 2. Droughts destabilise carbon stored in peat, leading to greater DOC flux. Current programmes to raise water tables should mitigate this.

Peatlands are a globally significant store of carbon

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Many peat catchments are sources for drinking water

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DOC must be effectively removed to meet drinking water standards. Any increase in DOC causes increased operational costs.

Conclusions

- DOC production is in the order *Molinia* > *Juncus*> *Calluna*> *Sphagnum*> peat soil
- More frequent droughts will produce higher DOC flux from peat soils
- The grassland species *Molinia* and *Juncus* produced DOC which is easier to remove than *Sphagnum*, however this does not compensate for their much greater flux
- DOC source is more important than climate controls on production for drinking water treatment

These results support catchment management programmes which encourage *Sphagnum* as these should lead to lower DOC flux.

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