Upscaling Peatland Diversity and Carbon Dynamics to the Ecosystem Level

Mike Whitfield[1], Nick Ostle[1], Richard Bardgett[2], Rebekka Artz[3], David Beilman[4]

1) Centre for Ecology and Hydrology, Lancaster Environment Centre, Library Avenue, Bailrig, Lancaster. LA1 4AP. UK.

2) Soil and Ecosystem Ecology, Lancaster Environment Centre, Lancaster University, Lancaster LA1 4YQ, UK.

3) Soils Group, The Macaulay Institute, Craigiebuckler, Aberdeen, AB15 8QH, UK. 4) Department of Geography, University of Hawai'i at Manoa, Honolulu HI 96822, USA.

miit@ceh.ac.uk mikewhitfield.wordpress.com

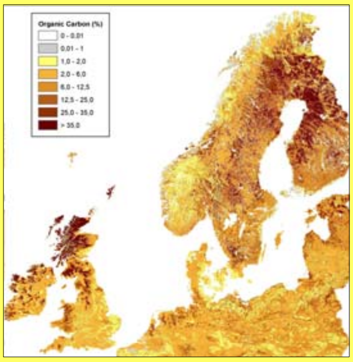
1. Introduction

Ongoing climate warming is closely linked to the terrestrial carbon cycle (Friedlingstein et al. 2003) and is projected to be greatest over high northern latitudes (Trenberth et al. 2007).

Peatlands constitute between one quarter and one third of the terrestrial carbon pool (Holden, 2005). Peatland plant communities represent aggregations of traits that influence the characteristics of organic material entering the soil (De Deyn et al. 2008). Above-belowground links between traits partly determine the rate at which soil carbon is decomposed and respired via the microbial community.

Northern peatland carbon stores are vulnerable to climate warming.

Above- and below-ground biodiversity links are major drivers of peatland carbon dynamics.



Much of the organic carbon found in northern European soils is stored in peatlands (Jones et al. 2005).

2. Objectives

Reliable estimates of peatland carbon stocks are vital for quantifying climate – carbon cycle feedbacks. However, the complex spatial heterogeneity of peatland plant communities and associated carbon dynamics represents a key source of uncertainty.

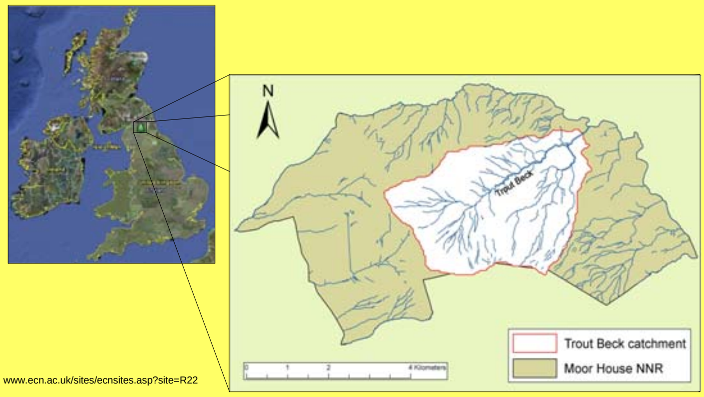
Upscaling carbon dynamics from plant community to ecosystem scales is a way of resolving uncertainty.

I. Characterise ecosystem-scale relationships between plant community composition, below-ground microbial community structure, and peatland carbon dynamics

II. Use these relationships to upscale and extrapolate peatland carbon dynamics from the plant community to the ecosystem scale

3. Study Site

The Trout Beck catchment is an 1146 ha area within the Moor House National Nature Reserve. Vegetation principally dominated by *Calluna vulgaris, Eriophorum* spp. and *Sphagnum* mosses. Soils consist of 90% blanket peat, with some mineral soils at higher altitudes. Altitudinal range: 535 – 848m.



www.ecn.ac.uk/sites/ecnsites.asp?site=R22

4. Methods

Creating a spatio-temporal dataset

I. Plant community composition, focusing on the relative cover of functional types
II. Below-ground microbial functional diversity and composition, using T-RFLP (Terminal Restriction Fragment Length Polymorphism) and PLFA (PhosphoLipid Fatty Acids) approaches
III. Time-series CO_2 and CH_4 flux measurements from representative vegetation patches
IV. Peat cores, analysed at 5cm increments for carbon content, resource quality and microbial community structure
V. Radiocarbon dating of peat cores to determine carbon accumulation rates

Looking for spatial patterns and relationships

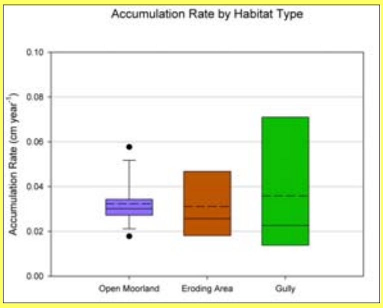
Between plant community composition, microbial diversity, and carbon dynamics, such as carbon accumulation rate and mean residence time

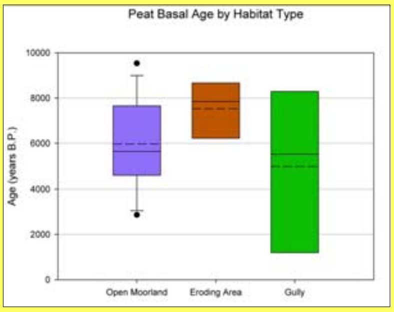
Spatially modelling carbon storage and dynamics at Moor House

Applying relationships between plant communities, microbial diversity and carbon dynamics to remotely-sensed data, and using **geostatistics** such as regression kriging to extrapolate over the Trout Beck catchment

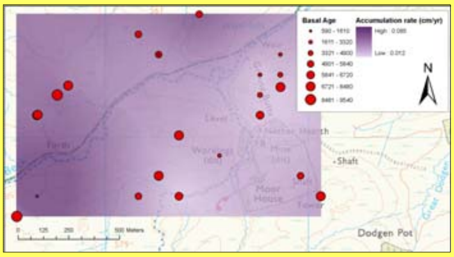
5. Preliminary Results

- Basal ages for 22 peat cores within a sub-area of the catchment were obtained using ^{14}C AMS. These were calibrated using Calib 5.1 (Stuiver and Reimer 1993) and the mid-points of the 2-sigma age ranges used as calibrated basal ages. Accumulation rates were calculated using the basal ages, assuming the bog surface as present day. These are summarised below.
- The spatial distribution of the radiocarbon dates is displayed on the map (top right). Kriging was used to create a surface showing the spatial variation in accumulation rates, which are greater towards the south-west and the north-east of the sub-area.

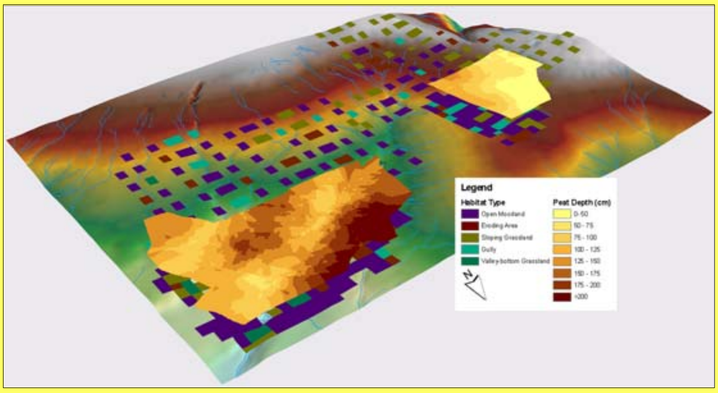




Two-sample T-tests showed no significant differences in basal ages or accumulation rates between habitat types ($P = 0.05$).



The figure below shows habitat data collected from 419 vegetation plots, and peat depth data interpolated over two sub-areas using kriging.



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References:

De Deyn, G.B., Cornelissen, J.H.C. and Bardgett, R.D. 2008: Plant functional traits and soil carbon sequestration in contrasting biomes. Ecology Letters 11, 516-531.

Friedlingstein *et al.* 2003: How positive is the feedback between climate change and the carbon cycle? Tellus 55B, 692-700.

Holden, J. 2005: Peatland hydrology and carbon release: why small-scale process matters. Philosophical Transactions of the Royal Society of London. Series A 363, 2891-2913.

Jones *et al*. 2005 Estimating organic carbon in the soils of Europe for policy support. European Journal of Soil Science 56, 655-671.

Stuiver, M. and Reimer, P.J. 1993: Extended ^{14}C data base and revised Calib 3.0 ^{14}C age calibration program. Radiocarbon 35, 215-230.

Trenberth *et al*. 2007: Observations: Surface and Atmospheric Climate Change. In: *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.