Unsaturated peatland hydrology and its control on ecosystem resilience within a changing climate

Supervisors: Drs Nick Kettridge and Chris Bradley.

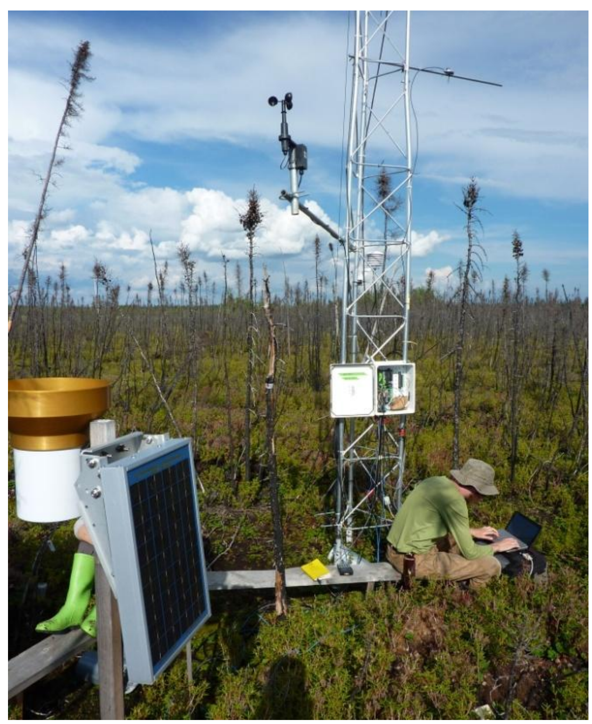
Abstract.

Water movement within unsaturated peat controls rates of evaporation and is fundamental in determining the resilience of peatland carbon stores to changing climatic conditions. This project will investigate the unsaturated hydrology of U.K. and Canadian peatlands, combining field and laboratory studies with computer simulations to project the response of essential ecosystem services to server drought. It will identify the potential of these systems to regulate their moisture contents and maintain good ecosystem health and project the vulnerability of these globally important carbon stocks to wildfire. This interdisciplinary research project will develop exciting links between hydrology, micrometeorology and ecology and expand on key connections with international research institutions.

Introduction

Peatlands are an essential hydrological resource and an important carbon store and climate regulator, containing 10% of the global liquid surface fresh water supply and representing one third of the global soil carbon pool. The resilience [*Gunderson*, 2000] of these important ecosystem services to changing climatic conditions is uncertain and peatlands may, for example, provide an important source of atmospheric carbon under a changing climate [*Frolking*, 2006]. Unsaturated moisture dynamics provide an essential control on these essential ecosystem services. For example, near surface moisture content and tension controls the rate of carbon sequestration [*Thompson and Waddington*, 2006] and the vulnerability of carbon stocks to wildfire [*Benscoter et al.,* 2011]. However, unsaturated moisture dynamics have largely been ignored within peatland ecohydrological models. Such models instead focus on processes occurring beneath the water table and either do not represent the unsaturated zone [e.g. *Baird et al*., 2011], or apply simplistic empirical relationships that cannot project peatland ecohydrological function under changing climatic conditions [*Granberg et al*., 1999].

This project will model the unsaturated hydrology of U.K. and Canadian peatland ecosystems, simulating the movement of water through the peat profile and its loss via evaporation to the atmosphere; developing on the approach of *Price and Whittington* [2010]. Model simulations will be parameterised and evaluated against controlled laboratory investigations and short-term field based manipulations experiments to stress the ecohydrological system and characterise evaporation rates under extreme drought conditions. Under such conditions, the surface peat may become disconnected from the subsurface water supply, reducing evaporation to negligible values. If this disconnection occurs, it would provide a critical feedback response that would restrict water losses and enhance ecosystem resilience. This improved understanding of the peatland hydrological systems will be applied to project the response of peatland ecosystems under changing climatic conditions from downscaled ensemble climate data [*Roulet et al.,* 1992] and to determine the vulnerability of peat profiles to wildfire [Benscoter *et al.,* 2011]



Working within an interdisciplinary project, the research student will develop knowledge within hydrology, micrometeorology and ecology and develop important skills in numerical modelling, and laboratory and field based research. This will occur within in a large and active graduate research school within the School of Geography Earth and Environmental Sciences at Birmingham with strong links to the Canadian Forestry Service and institutions from the PEATFIRE research group (http://www.uoguelph.ca/peatfire/Peat_Fire/Home.html).

For more information please contact:

Gretchel Coldicott (g.coldicott@bham.ac.uk)

or the potential supervisors: Nick Kettridge (kettrin@mcmaster.ca), Chris Bradley (c.bradley@bham.ac.uk),

References

Baird, A. J., P. J. Morris and L. R. Belyea (2011) The DigiBog peatland development model 1: rationale, conceptual model and hydrological basis, *Ecohydrology*, in press.

Benscoter, B.W., D.K. Thompson, J.M. Waddington, M.D. Flannigan, M. Wotton, W. DeGroot and M.R. Turetsky (2011) Interactive effects of vegetation, soil moisture, and bulk density on the depth of burning of thick organic soils, *International Journal of Wildland Fire*, 20, 418-429.

Frolking, S., N. Roulet and J. Fuglestvedt (2006) How northern peatlands influence the Earth's radiative budget: Sustained methane emission versus sustained carbon sequestration, *Journal of Geophysical Reserach*, 111, G01008.

Granberg, G., H. Grip, M. Ottosson Löfvenius, I. Sundh, B. H. Svensson and M. Nilsson (1999) A simple model for simulation of water content, soil frost, and soil temperatures in boreal mixed mires, *Water Resources Research*, 35, 3771–3782.

Gunderson, L.H (2000) Resilience in theory and practice, *Annual Review of Ecology and Systematic*, 31, 425-439.

Price J. S., and P. N. Whittington (2010) Water Flow in Sphagnum Hummocks: Mesocosm measurements and modeling, *Journal of Hydrology*, 381, 333–340.

Roulet, R., T. Moore, J. Bubier, P. Lafleur (1992) Northern fends: methane flux and climate change, Tellus, 44B, 100-105.

Thompson, D. K., J. M. Waddington (2008) Sphagnum under pressure: towards an ecohydrological approach to examining Sphagnum productivity, *Ecohydrology*, 1, 299-308.