Effects of changing climate on peatland in Lapland (Finland): greenhouse gas sink or source? (Ref IAP-16-82)

Newcastle University, School of Civil Engineering & Geosciences
In partnership with Department of Geography, Durham University

Supervisory Team
- Dr Geoffrey Abbott, Newcastle University
- Dr Erin McClymont, Durham University
- Dr Minna Väliranta, University of Helsinki, Finland

Key Words
Finland, peatland, Sphagnum, greenhouse gases, environmental change

Overview

One of the general findings from the latest Assessment Report of the United Nations IPCC is that warming of the atmosphere and ocean system is unequivocal. There is also no doubt that this will impact on northern peatlands which store about 550 Gt of carbon equivalent to approximately one third of global C stocks and 75% of the total pre-industrial amount of C stored in the atmosphere. The question addressed in this study is which of the following two types of feedback to climate warming is occurring in such ecosystems: positive feedback (acceleration of peat decay) or a negative feedback (an increase in carbon sequestration rate).

Peatland plants such as Sphagnum moss fix CO₂ through photosynthesis and then store it as dead plant matter - peat! When this peat decays above the water-table, aerobic degradation causes release of CO₂. But when the peat decays in places where oxygen is absent, below the water-table, both methane (CH₄) and CO₂ are emitted. It is well known that the problem with CH₄ in the atmosphere is that it has a stronger warming effect than CO₂. As evidence emerges of an intensifying global hydrological cycle, a pattern of dry regions becoming drier and wet regions becoming wetter is anticipated. These changes will impact upon the extent of seasonal depth fluctuations in peatland water tables and, in turn, on the emissions of greenhouse gases from northern peatlands. Our working hypothesis is that “bound” Sphagnum-derived phenolics, which inhibit microbial decomposition of the cell wall polysaccharides, will be stabilised in peatlands shifting to a wetter climate. In contrast, they will be gradually stripped away in surficial peats exposed to a drier climate, such that any rewetting of the peat could lead to anaerobic fermentation of the carbohydrates thereby increasing the vulnerability of the peat to further decomposition (Abbott et al., 2013; Swain & Abbott, 2013).

Core aim
To understand the relationship between the accumulation, as well as the degradation, processes of Sphagnum peat and seasonal water-table fluctuations in a northern peatland. This is important because it
will determine the factors that control carbon release (both as carbon dioxide and methane) in the context of a changing climate. We will do this by comparing the C$_{org}$ stocks and their molecular compositions as a function of distance from the water table at selected coring stations in the aapamire zone in Lapland, Finland (Figure 2). These sites belong to the ICOS (Integrated Carbon Observation System) network (http://eng.icos-infrastructure.fi/). Continuous measurements are currently taking place at these sites. We will achieve the aim by combining these instrumental observations with detailed molecular characterisation of the peats. Our long term vision is progress towards carbon capture and storage using natural ecosystems.

**Project plan**

To understand the two-way relationship between water-table position and the phenolic biochemistry of the living plants, as well as the litter and the peat, we must monitor the water-table fluctuations in real time continuously. We will do this at hourly intervals at each coring station using self-logging pressure transducers (data loggers) which will be installed and monitored in collaboration with Dr Minna Väliranta (University of Helsinki). We will also measure both the densities and C$_{org}$ contents in the unsaturated, seasonally-saturated and the permanently saturated layers of the peats. The molecular compositions of these peats will be characterised using gas chromatography/mass spectrometry (GC-MS) and/or liquid chromatography/mass spectrometry (LC-MS). Laboratory experiments will also be run to experimentally test for oxidative mechanisms for the decomposition of Sphagnum and vascular plant-derived phenols. We aim to test whether a changing water table will significantly affect the carbon storage as well as the antioxidant capacity of the peat.

**Project timeline**

**Year 1:** Fieldwork for collection of peat cores, installation and monitoring of data loggers, literature review. Molecular analyses and C$_{org}$ contents.

**Year 2:** Fieldwork for collection of peat cores, installation and monitoring of data loggers. Molecular analyses using GCMS & LCMS, construct age/depth model for peat bog, paper 1.

**Year 3:** Experiments to test for oxidative mechanisms for the decomposition of Sphagnum and vascular plant-derived phenols. Synthesis of field measurements with age/depth model. Paper 2.

**Year 4 (6 months only):** Thesis, paper 3.

**Training & Skills**

Training is fundamental to the development of postgraduate research students and, together with the DTP, University and School we provide a substantial training programme. Priorities for training are determined from the ‘Training Needs Analysis’ carried out in the initial supervisory meeting with the student.

School training in (a) research skills and techniques and (b) research environment are provided through four mechanisms: (i) a programme of MSc taught modules; (ii) internal training ‘workshops’ that focus on key geochemical research skills and techniques; (iii) input from supervisors.

Students receive instruction in data collection and the scientific method, contextualizing and problematizing research in biogeochemistry, planning for field- and laboratory work, and team and group working in biogeochemistry. Assessment of students in this module is formative. There is also extensive generic training offered by Newcastle University.

Research training continues through the second and third years, and is based around a number of themes: Recognition and validation of problems; Demonstration of the original, independent and critical thinking, and the ability to develop theoretical concepts; Knowledge of recent advances within research field and in related areas; Understanding relevant research methodologies and techniques and their appropriate application within research field; Ability to analyse and critically evaluate findings and those of others; and Summarising, documenting, reporting and reflecting on progress.

---

**Figure 2:** ICOS coring stations in Finland
References & Further Reading


Further Information
Dr. Geoffrey Abbott  
School of Civil Engineering & Geosciences  
Drummond Building  
Newcastle University  
Newcastle upon Tyne  
NE1 7RU, United Kingdom  
Email: geoff.abbott@ncl.ac.uk  
Tel.: +44 (0)191 222 6608  
[http://www.ncl.ac.uk/ceg/staff/profile/geoff.abbott](http://www.ncl.ac.uk/ceg/staff/profile/geoff.abbott)