11. Assessment of land use change on peatland carbon budgets (WP 2.7)

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11.1 Introduction

Peatlands represent the largest store of carbon in UK ecosystems. Carbon balance of these peatlands will be affected by changes in land use, and they have the potential to act as a major carbon source or sink. Historically, the main land management pressures have come from grazing, burning (management for grouse), drainage and afforestation. In recent years, there has been a major move throughout the UK towards reversal of afforestation and drainage practices: conifer plantations have been removed and the natural hydrology re-established to raise the water table. This is likely to have a major impact on the carbon balance of restored peatlands, although the magnitude and direction of these changes is not clear. Caithness and Sutherland have the largest area of blanket bog in the UK, of which 150 000 ha are "severely affected" by drainage, and major initiatives are in place to reverse this (LIFE Peatlands Project 2005). Here, we aim to quantify the effect of this reversal in hydrological management on a peatland site in Sutherland, and provide estimates of the impact of these practices at a regional scale.

The original experimental plan was to measure the carbon balance on a drained site, before and after drain blocking. However, after extensive searching and consultation with land owners, no suitable sites could be found where drain blocking is planned in the next few years. Instead, we plan, and are in the process of setting up, a three-way comparative experiment with sites that are pristine, drained, and drain-blocked, at the RSPB reserve at Forsinard, Sutherland. The original experimental design had the disadvantage that differences in climate before and after drain blocking could not be accounted for. The new design has the advantage that all sites experience the same climate over the course of the experiment, and that the comparison with a pristine site can be included to give an appropriate baseline. The disadvantage is that we ascribe differences to a treatment effect when there could be inherent differences between sites. This problem is minimised by choosing sites as close together and as comparable as possible in all other aspects. The sites chosen at Forsinard are very well-suited in this respect, all being within a few kilometres and otherwise similar.

11.2 Site and Methods

The research is focussed on 3 sub-catchments of the River Dyke near the Cross Lochs, 4 km north-west of the RSPB Visitor Centre at Forsinard Station (58^{o} 24'N, 03^{o} 58'W) in Strath Halladale, Sutherland (Figure 11-1). The three sites represent areas of contrasting types of peatland management:

1. Cross Lochs South – a 2 km^2 **pristine** peatland catchment which drains west from a bog-pool system to the River Dyke.
2. Cross Lochs North – a 2 km^2 catchment containing **drain-blocked** (80%) and deforested (20%) peatland. Drain blocking using a combination of peat dams and plastic inter-locking sheets occurred during 2002-2003.
3. Allt a'Bhunn – located 6 km north of Cross Lochs on the Bighouse Estate, the Allt a'Bhunn catchment consists of a 4 km^2 area of intensively **drained**

peatland. Drainage occurred in the 1960/70s with parallel drains constructed at a spacing of 50 m.

The use of three sites necessitates a change in methodology, as there is only one eddy covariance system for measuring landscape-scale CO_2 fluxes. The eddy covariance system will be located at the pristine site, to give the background atmospheric flux for the undisturbed state. Surface fluxes of CO_2 and CH_4 will be measured using chambers at all three sites, as this allows replication and statistical analysis of between-site differences. These chamber methods can also be used to do manipulative experiments, deriving responses to light, temperature, soil moisture, and to investigate spatial heterogeneity. Changes in water table depth will be measured continuously at the pristine site and monthly at the other 2 sites. The fluvial fluxes will be measured at all three sites by monitoring discharge (continuously) and total carbon content (fortnightly water samples). Sites were selected in May 2007 and will be instrumented from June 2007. A post-doctoral researcher (Sarah Crowe) at the Environmental Research Institute (ERI) in Thurso, will carry out the bulk of water sampling and chamber flux work.

Predicting changes in the store of carbon within the soil resulting from changes in land use or climate requires a process-based model. Historically, such models have been developed for conditions typically encountered in intensive agricultural systems, such as arable crops and improved pasture, where mineral soils predominate. However, much of the soil carbon within the UK is found in highly organic soils, in upland areas where land management is minimal, and the climate is cool and wet. Existing soil models (such as RothC) fail to capture the dynamics of carbon in these highly organic soils, largely because of differences in soil chemistry, soil fauna and microbial community composition**.** Basic measurements of model parameters (turnover rates, pool sizes) and variables (carbon fluxes in, out and between pools) necessary for validation are lacking. Here, our field measurements produce the data required for developing and validating a process-based model of carbon dynamics under these conditions. Mechanistic modelling based on these measurements and the existing records will be used to predict the longer term changes in carbon storage within this catchment. Long-term records and GIS databases are available for many of the critical input variables for modelling: meteorology, hydrology, stream water chemistry and vegetation. These will be used to extrapolate estimates of the carbon balance over the regional scale and longer time spans.

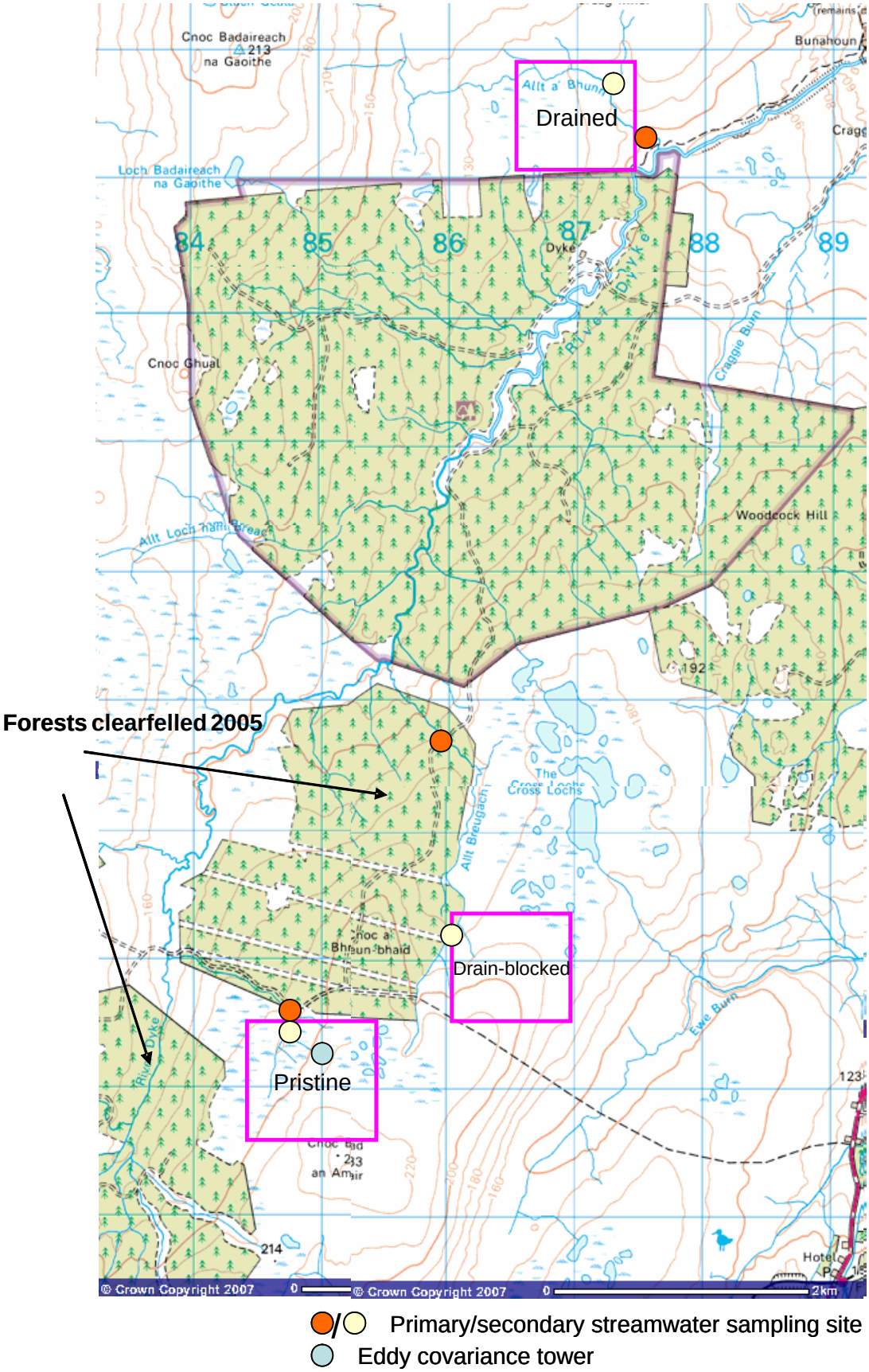

Figure 11-1: Location of the field sites and eddy covariance measurement tower within the RSPB Forsinard reserve, Sutherland.

11.3 Collaboration with partner institutes

In addition to the study of carbon fluxes, the following measurements will be made by contributing partners:

- ERI (Sarah Crowe) – impact of peatland management on vegetation. This will involve detailed site-specific survey work and vegetation mapping aimed at examining successional change within the bogs in response to restoration. The results will also enable the upscaling of chamber CO_2 and CH_4 flux measurements to the whole catchment.
- RSPB (Norrie Russell, Neil Cowie) – quantification of the impact of peatland management on biodiversity. The work is primarily based on the use of pitfall traps to measure invertebrate distribution and density (as a food source for birds).
- Macaulay (Rebekka Artz and Martin Sommerkorn) – below ground measurements of the affects of peatland management on soil ecosystem functioning. This will involve quantifying carbon turnover, C/N interactions and soil microbial diversity.

The primary aim of the project is to better understand the impact of peatland restoration on carbon cycling and to inform policy makers and land managers about ways of optimising peatland carbon storage and biodiversity.

11.4 References

LIFE Peatlands Project (2005) The Peatlands of Caithness & Sutherland - Management strategy 2005 - 2015, pp 52.

11.5 Acknowledgements

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