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ESTIMATION OF AQUATIC CARBON BUDGETS FROM A PEATLAND CATCHMENT AFFECTED BY WIND FARM DEVELOPMENT IN SCOTLAND, UK

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SUMMARY

Due to their high wind yields and low agricultural value, many areas of peatland in Scotland are considered by renewable energy companies as ideal locations to build wind farm developments. Peat excavation for turbines bases, high voltage cabling and on-site road networks associated wind farm developments has the potential to disrupt the natural carbon cycling of these peatland landscapes therefore it is important to assess any environmental impact of construction activities. Research is ongoing to estimate carbon budgets from catchments affected by the construction activities associated with the Gordonbush wind farm development project, near Brora, Scotland.

KEY WORDS: Carbon budget, dissolved organic carbon (DOC), wind farm

INTRODUCTION

Scottish peatlands are under increasing pressures from wind farm developers who consider their locations ideal sites for hosting wind-power based renewables (Nayak *et al*., 2008). Therefore, it becomes important to assess the, currently unknown, impact of construction activities on the natural landscape to investigate whether peatlands are acting as sinks or sources of carbon and predict a carbon payback time. Our main objective is the construction of modern day aquatic carbon export budgets as well as investigation of past carbon export from the landscape using lake sediments. This will identify missing attributes of peatland functioning as well as contextualising aquatic carbon and sediment export over timescales longer than wind farm construction, thus providing a historical context for assessing the significance of losses during the construction period.

The focus of this research is Gordonbush Estate, near Brora, Scotland, (58° 06’33 N, 03° 56’11 W), a peatland site where wind farm construction of 35 turbines started in September 2010. Research activities began in May 2010, and are part of a wider habitat management plan (HMP) including deer, forestry and heather management associated with the redevelopment of the estate and improving the peatland habitat within it. Gaseous losses of

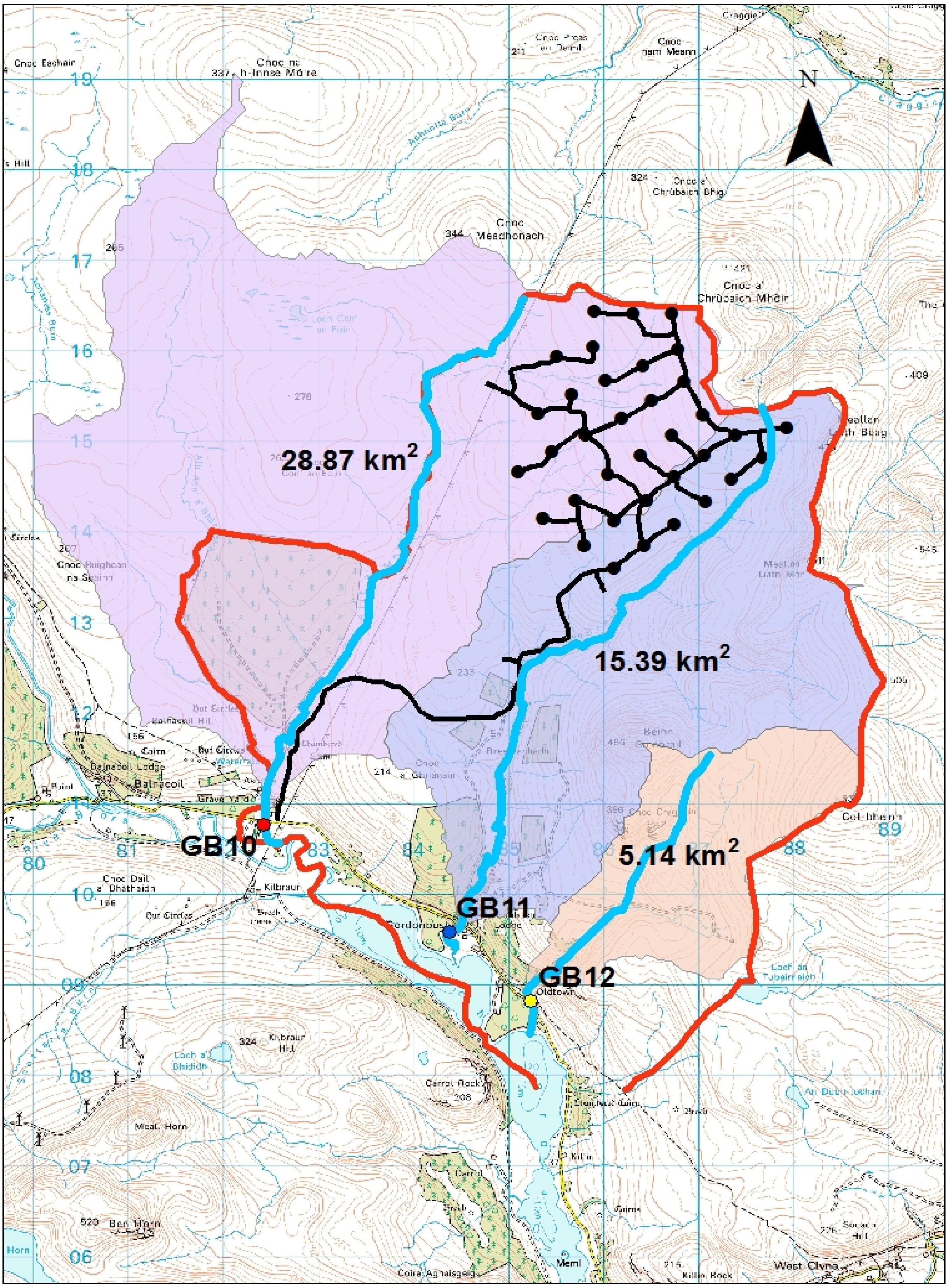

Figure 1. Gordonbush field site. The red outline marks the boundary of the Gordonbush Estate. The black lines indicate the wind farm road network and the black dots the turbine locations. The size and outline of each catchment within the Gordonbush Estate are marked and the main rivers in the catchment are highlighted in a light blue. Sampling points are marked at the foot of catchments, GB10 = Allt Mhuilin, GB11 = Allt Smeorail, GB12 = Old Town Burn.

carbon are difficult to measure over large scales, so our research has focused on measuring aquatic carbon losses in three rivers catchments on the Gordonbush Estate.

At Gordonbush, two rivers drain entirely the wind farm development: the Allt Mhuilin river drains the western area and the Allt Smeorail river drains the eastern area. A third river catchment, the Old Town Burn, does not drain the windfarm and so acts as the 'control' for carbon and sediment export when unaffected by wind farm construction activities.

Storm events were targeted to characterise carbon concentrations, as it has been acknowledged that 50% of carbon export occurs during 10% of highest river flows (Hinton *et al.*, 1997). This sampling strategy allows better estimates of carbon export to be made rather than single samples taken on either daily, weekly or monthly intervals.

Although, construction activities will be completed, and the wind farm operational by April 2012, research will continue until December 2014 in conjunction with the HMP to investigate post-construction carbon export to fully characterise any potential impact of the wind farm development.

MATERIAL AND METHODS

A litre sample of water is collected every 4 hours from start through until end of event (judged to be when stage height at sampling point returns to pre-event level), from each of the three rivers at the foot of each catchment in the, Allt Mhuilin, Allt Smeorail and Old Town Burn, (subsequently coded GB10, GB11 and GB12 respectively.)

Each litre sample is filtered within two hours of collection, to preserve integrity of sample, through a pre-ashed 0.7µm GF/F glass fibre filter paper. The volume of sample filtered is weighed to accurately calculate a volume and enable calculation of POC concentration, [POC]. Fifty ml of the filtrate is retained for measurement of DOC concentration, [DOC]. The samples were stored in a refrigerator until required for [DOC] assay, then acidified to pH 4 before agitation in an ultrasonic bath for 15 minutes to remove the inorganic carbon (IC) fraction. [DOC] is measured using a Thermolux® Carbon Analyser. [POC] is estimated from the loss of mass from the GF/F filter papers heating to 375°C for 16 hours, corrected for the volume of sample filtered and percentage of the lost mass that is organic carbon (Ball, 1964).

Automatic pressure transducers (PT), measuring stage height every 15 minutes, are present in all three rivers, near to the existing sampling points. Discharge was measured over a range of different stage heights at each location to produce river discharge ratings curve equations. Using these relationships the hydrographs for each river could be reconstructed from the PT records. Discharge, [DOC] and [POC] data collected was correlated to produce statistical relationships to predict carbon concentration during non-sampled periods and produce a carbon budget for each catchment area. Data sets have been spilt to better account for varying statistical relationships based on seasonal differences in carbon export as well as relationships between the export on the falling and rising limb of storm events.

RESULTS

We will present out observations of carbon concentration against stage height and how this varies with season as well as during events. We will present preliminary budgets of C export for each of the catchments.

At the moment it is not possible to detect an impact of the windfarm on the different catchments.

DISCUSSION

Attempts will also be made to contextualise estimated annual carbon budgets throughout the duration of the research (2010-2014) into a historical context and trend of carbon export at Gordonbush over the last 1000 years by comparing data generated to estimations of inferred carbon export by analysing sediment cores from various locations around the wind-farm development.

Estimations of carbon budgets will allow an assessment to be made of any impact of wind-farm construction and resilience and adaptation of the landscape to hosting land-based renewables, thus contribute to developing best land management practices regarding wind farm construction on peatlands.

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