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Quantifying impacts of windfarm development on peatland for aquatic carbon, nitrogen and phosphorus fluxes

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Many onshore windfarms in Scotland are being built on peatlands; consequently the impacts of construction-related activities on the peatland itself and downstream environments are an important emerging issue. For example, a reduction of the quantity of carbon (C) stored in the peatland and increased phosphorus (P) and nitrogen (N) concentrations in streams may cause changes in the peatland C sink strength and aquatic C emissions and exceedance of EU Water Framework Directive (WFD) threshold values, respectively. Quantifying the fluxes of C, N and P via streams draining peatland has often been overlooked when assessing impacts from peatland based development.

To address this gap, a three-weekly streamwater monitoring programme has been conducted from August 2011 at a site in central Scotland, UK, where windfarm construction on peatland is ongoing. Eighteen streamwater sampling points were selected in the study catchment area of 11.5 km^2 to assess the effect on aquatic fluxes of the typical activities involved in windfarm construction on peatland in the UK. These are: excavation of peat to install turbine bases and cable trenches, excavation of quarries to obtain hardcore for windfarm roads, the construction of roads and associated drainage, and forest felling to create space for the turbines and increase wind fetch. Streamwater samples were analysed for dissolved organic carbon (DOC), particulate organic carbon (POC), alkalinity, total oxidisable nitrogen (TON: NO_3^- + NO_2^-), soluble reactive phosphorus (SRP) and total phosphorus (TP). Exports of DOC, POC, TON and SRP have been calculated using continuously monitored flow data from the catchment outlet, scaled to the sub-catchment area of each sampling point.

To date, streamwater [DOC] has ranged from 6.2 to 89 mg l^{-1}, [TON] from 0.01 to 7.2 mg l^{-1}, [POC] from 0.02 to 18 mg l^{-1} and SRP concentrations from 4 to 516 μg l^{-1}. [TON] was not considered an issue in the streams since P is the limiting nutrient. [DOC] measured at the catchment outlet and the control sampling point in the headwaters are very similar, despite the increase in flow between the two points, indicating contributions to DOC from the land use activities in the catchment. The annual mean [SRP] at sampling points downstream of forest felling exceeded the "poor" WFD threshold value of 150 μg l^{-1} for an upland stream with annual mean alkalinity below 50 mg l^{-1} as $CaCO_3$. A GIS analysis is being conducted to assess the extent to which construction-related activities control concentrations and fluxes of aquatic C, N and P. The results of this can be used to suggest how to improve windfarm construction on peatland so as to limit negative impacts on C storage and emissions and on aquatic ecosystems.

Keywords: carbon cycle, DOC, forest felling, peatlands, phosphorus, windfarms