Pre-restoration carbon dioxide emissions of an upland eroded peatland, Scotland, UK.

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Introduction

The carbon emissions from peatlands in Scotland have recently been estimated at 6.1 Mt CO_2 equivalent per year [1*], due to the large proportion of Scottish peatlands that are in a damaged state.

The Peatland Action programme aims to help bring 50,000 hectares back on the road to recovery by 2020.

This project aims to add to the evidence base of the carbon mitigation potential of restoration activities. Specifically, we focus on eroded upland sites, which are one of the more challenging type of sites to restore.

Eroded peatlands cover an estimated 275kha in Scotland, yet continuous monitoring data on the carbon losses from such sites are very sparse, in part due to the challenge in instrumenting such remote and complex terrain with eddy covariance equipment.

We present a full, pre-restoration, annual carbon dioxide budget from a typical Scottish eroded peatland.

Acknowledgements
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Methods

An eddy covariance flux tower (CO_2/H_2O and energy terms only at present) has been installed at an eroded blanket bog location at 650 m elevation in the Cairngorms National Park (Fig 1, far left). The site has now been running since early July 2018 and is powered by a combination of a solar array and a methanol fuel cell to augment power under low sunlight conditions. The tower footprint[2] is dominated by a high proportion of bare peat in gullies (middle and far right).

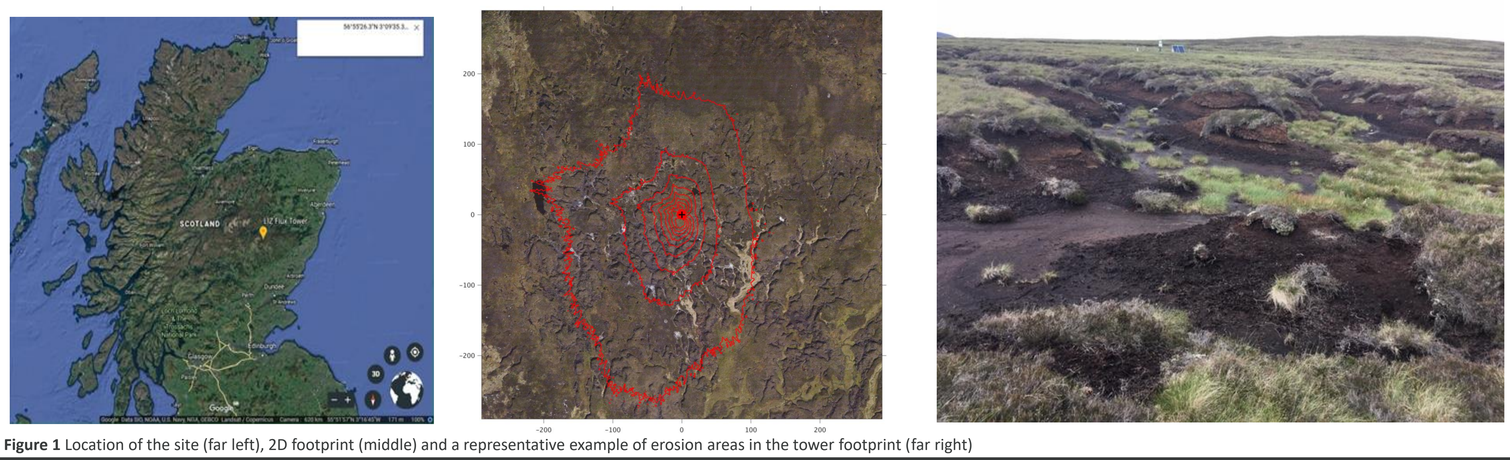
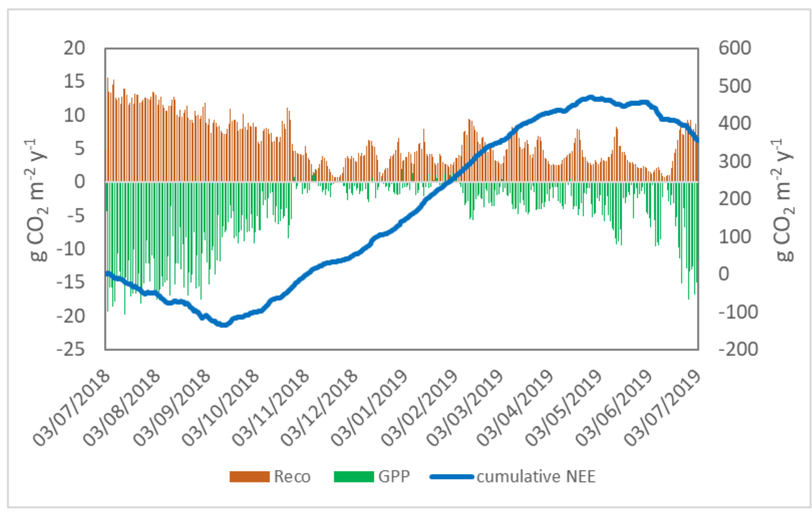


Figure 1 Location of the site (far left), 2D footprint (middle) and a representative example of erosion areas in the tower footprint (far right)

Results



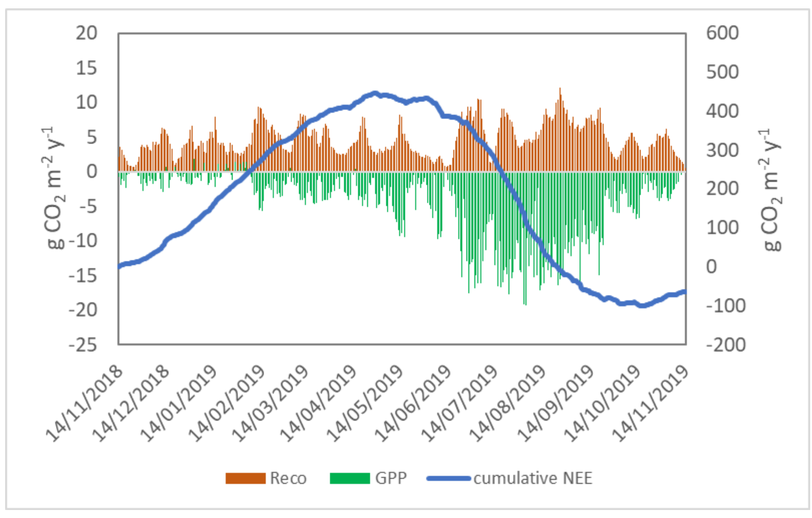


Figure 2 Daily GPP (green bars) and Reco (brown bars) at the eroded blanket bog site (Cairngorms, Scotland, UK) over the course of two 365-day periods (upper figure starts earlier in 2018), plotted with cumulative NEE (blue line) on the secondary axis.

- The data processed to date span just over 16 months (499 days). This allows us to produce a rolling annual carbon dioxide budget across this time frame (Figure 2). Preliminary energy balance closure results and relevant other observations can be seen in Figure 3.
- Our preliminary analysis suggests that the site was a net source of carbon dioxide (347 g CO_2 m^{-2} y^{-1}) in the 365 days following the start of July 2018 (i.e. including a major drought) but a sink (-64 g CO_2 m^{-2} y^{-1}) if considering the 365 days starting November 2018.

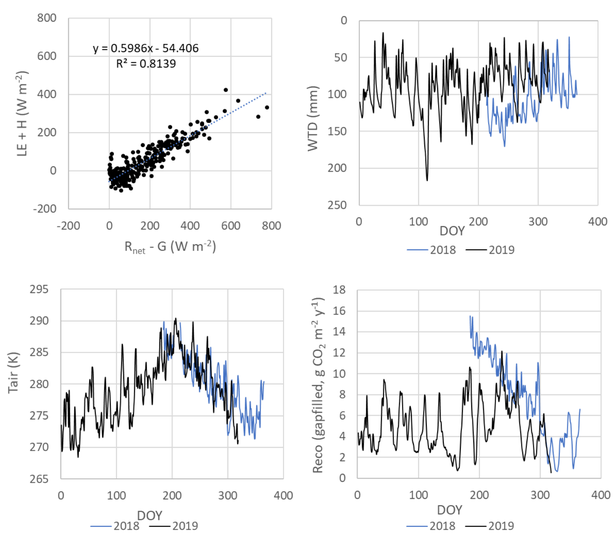


Figure 3 Energy balance closure (top left, combined daily data over 14 months). The other panels show the differences in water table depth (top right), air temperature (bottom left) and gapfilled ecosystem respiration (bottom right) between overlapping observation periods across the two monitoring years. GPP showed no significant differences between overlapping observation periods (not shown).

Discussion & Conclusions

- To our knowledge, this is the first study to monitor continuous carbon dioxide emissions from an eroded peatland. The results suggest sensitivity of the sign of the net annual CO_2 budget to interannual climate variability. The 2018 summer drought was an extreme event and we therefore believe that this site would generally be more likely to be net carbon dioxide emitting.
- The results fall within the envelope of estimated carbon dioxide emissions (-0.1 to 0.6 t CO_2-C ha^{-1} y^{-1}) from UK peatlands and those in similar climatic regions, as calculated for a set of draft Tier 2 UK emission factors[1.]
- Monitoring will continue beyond the restoration of this site (planned for winter 2020-2021). A linked PhD studentship (G. Donaldson-Selby, James Hutton Institute & University of the West of England) aims to assess the hydrological functioning of the wider catchment pre- and post-restoration.

References

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[2]Kljun,N.,P.Calanca,M.W.Rotach,H.P.Schmid,2015: A simple two-dimensional parameterization for Flux Footprint Prediction(FFP). Geosci. Model Dev., 8, 3695-3713. doi:10.5194/gmd-8-3695-2015.

* Figure for total emissions excludes emissions from afforested peatlands, as these are currently accounted for using Tier 3 methodology in the UK National Greenhouse Gas Inventory.

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