The impact of forest-to-bog restoration on net ecosystem carbon fluxes in northern Scotland.

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Introduction

Globally, peatland ecosystems account for approximately a third of soil carbon stocks. Scotland holds about 13% of world’s blanket bogs and Scottish peatlands store ~1620 Mt of carbon, which accounts for about 56% of total carbon in Scottish soils. However, the majority of Scottish peatlands (>80%) are degraded to some degree, mainly due to human intervention such as drainage, harvesting and afforestation, causing them to act as net sources of carbon to the atmosphere. The restoration of damaged peatlands has the potential to re-establish their carbon sink capacity.

In the Flow country of northern Scotland large areas of pristine peatland were afforested in the 1980s and are currently being restored by felling the forest stands and blocking drainage ditches and furrows. In order to better understand the time-dependent impacts of peatland restoration on carbon, water and energy dynamics, we have instrumented a chronosequence of four flux sites which include a near-pristine peatland, a mixed Sitka spruce and Lodgepole pine plantation planted on deep peat, and two recently restored sites (12- and 18-years-old). Here we present the initial results from data collected at our flux sites.

Methods

- Research site located on Royal Society for the Protection of Birds (RSPB) nature reserve in Forsinard, Sutherland, Scotland, UK. The reserve is about 215 km² of blanket bog.
- Four stations are located on the reserve to represent the various management stages: afforested; 2004 felling; 1998 felling; and a near-natural, pristine site.
- All four stations are equipped with meteorological and eddy covariance (EC) tower equipment; all four stations measure CO₂, water and energy exchange, and two also measure CH₄ using the EC method.
- Power supply at the sites consists of fuel cells, solar and wind.
- Data is processed using EddyPro and EdiRe software.

Results

<table>
<thead>
<tr>
<th>SITE</th>
<th>NEE (g C m⁻² yr⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dyke</td>
<td>80</td>
</tr>
<tr>
<td>Lonielist</td>
<td>-72</td>
</tr>
<tr>
<td>Talaeel</td>
<td>-114</td>
</tr>
<tr>
<td>Cross Loch*</td>
<td></td>
</tr>
</tbody>
</table>

- The table above summarizes the annual net ecosystem exchange (NEE) of carbon from the sites, measured in 2014 (based on CO₂ flux measurements). Negative values indicate uptake by the terrestrial ecosystem from the atmosphere. It can be seen that the youngest felled stand is a source of carbon, while by 18 years of age it may become a small sink, compared to the pristine stand.
- To the left are figures comparing the time-series of daily mean gross photosynthetic uptake, GPP (grey bars) and daily mean ecosystem respiration, Reco (black bars); and cumulative NEE for the two felled sites. The younger stand still has more CO₂ emissions to the atmosphere from ecosystem respiration, especially later in the growing season and into autumn and winter. Photosynthetic uptake is also lower at the younger stand where the vegetation cover did not yet have enough time to develop to the extent of the older stand.

Acknowledgements:

[Image: Acknowledgements image]

Conclusions

Preliminary results suggest that forest-to-bog restoration efforts could be a viable method of carbon sequestration in northern Scotland and can help the Scottish government meet its carbon reduction targets in the long-term. Long-term monitoring of fluxes is needed to establish interannual variability and also contributions from methane emissions should be assessed to complete the carbon budget for the site.