Looking deeper at blanket bog management for biodiversity, carbon and water

Dr Andreas Heinemeyer *has been a scientist at the Stockholm Environment Institute (SEI) in York (which is part of the Environment Department at the University of York) since 2002. His core research interests lie in terrestrial ecology and the carbon cycle. His work has focused on experimental and modelling work, using experiments to tease out the underpinning processes of how and how fast carbon cycles through terrestrial systems such as forests, grasslands and, more recently, upland bogs.*

There are different views about how the uplands, particularly bogs and other peatlands, should be managed. Some seek to manage habitats focusing on established management practices, particularly burning, favouring the grouse 'priority' plant, heather, and its structural (age) diversity. Others favour forms of land management that seek to maximise biodiversity and improve delivery of the related ecosystem services.

The importance of UK peatlands reflects not just their biodiversity but also their role as enormous stores of carbon. During photosynthesis, plants take up atmospheric carbon dioxide (CO_2) and use this carbon to store the sun's energy in form of sugar. Some of it is returned quickly through plant respiration from shoots and roots, while the remaining carbon is converted into organic matter which, after plants or their parts die, decays over time releasing the carbon back into the atmosphere, either as CO_2 or methane (CH_4). Crucially, waterlogged conditions and some plant specific compounds (e.g. from *Sphagnum* moss) suppress this decay or decomposition leading to 'active' peat formation, as carbon inputs exceed losses. In the UK, this has been the case over many millennia (since the last ice age), contributing to a net cooling effect on the global climate due to reducing atmospheric greenhouse gas concentrations. However, the balance of CO_2 *versus* CH_4 emissions is important, as CH_4 is a greenhouse gas with a 'global warming potential' about 25 times higher than CO_2. Whereas decomposition above the water table mostly produces CO_2, saturated conditions generally result in considerable CH_4 emissions, although some of this can be transformed into CO_2 by bacteria at the soil surface. Finally, each step you take over a blanket bog contains about 100 kg or more of carbon under your foot, most of which is more than 5,000 years old!

UK peatlands also provide other ecosystem services, in particular clean drinking water to millions of people (annually estimated to be worth many billions to the water industry), income to upland communities, and also recreational value to all of society. In the UK, many blanket bogs have been drained for grazing, often combined with regular burning; this frequently led to increased dominance of heather. However, there are indications that extensive areas of heather can dry the peat further as well as potentially causing underground erosion ('peat pipes') and suppressing 'active' peat forming plants such as *Sphagnum* mosses. Whilst the drains (grips) can be blocked to raise the water table and help restore active peat accumulation, it is therefore necessary to also understand the effects of dominance of heather, which might impede this process. Moreover, higher water tables also tend to benefit bird species feeding on soil animals (e.g. crane-flies) that rely on wet peatlands; and this includes grouse chicks.

Certain heather management strategies currently in use (e.g. burning) may have detrimental effects on, for example, peat carbon stocks, air quality or water quality and hence there is interest in alternative management techniques. However, choice of management strategies also depends on accessibility, suitability and feasibility, and needs to consider peatland condition. Therefore, management and restoration schemes must consider these and other environmental consequences, which are linked to fundamental ecosystem services. Importantly, the consequences of changes in management practice on

biodiversity, carbon dynamics and water quality are interlinked and likely to be slow to emerge so that long-term experimental monitoring is needed.

It is encouraging that government has recognised the importance of UK uplands in its review of UK uplands policy: "At the heart of the review is the recognition that our uplands provide us with a range of benefits including high quality food, clean drinking water and flood regulation, carbon storage, stunning landscapes and historic settlements and a range of habitats that support a diverse assemblage of species." (Pat Thomspon, *Defra take steps to secure more vibrant uplands,* Heather Trust's annual report, 2011). Moreover, there are already landowners and managers who try out alternative management within their grouse shooting and other moorland estates. So far, this is not so much based on 'hard' scientific evidence, but rather on their own experience of likely issues. Notably, the Moorland Association also recognises the need to promote a careful and balanced approach to heather management.

So, how can we assess the potential issues of heather dominance in relation to burning? Are there issues? And, more importantly, are their ways of managing the system that will allow grouse shooting and agricultural grazing whilst also supporting an increase in benefits to other ecosystem services? Although other approaches have been suggested (e.g. mowing), surprisingly, none of them has been compared to current burning regimes within a rigorous experimental design.

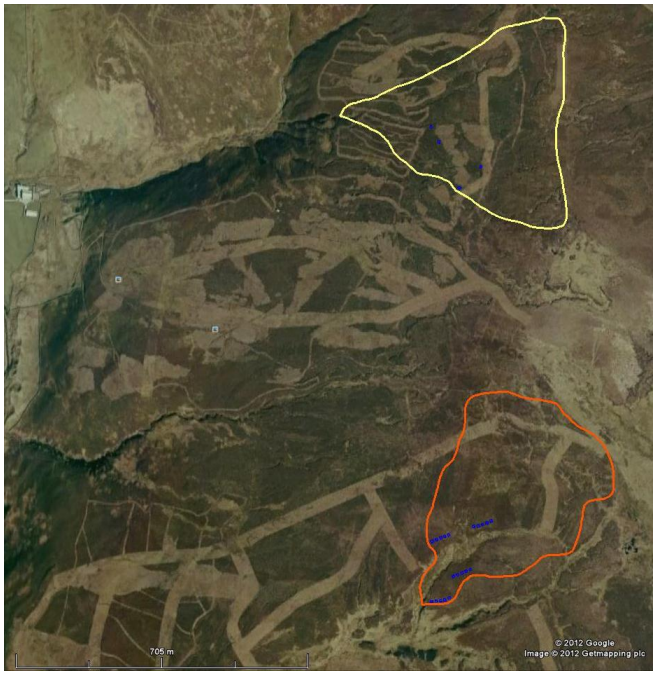
To address these issues, Defra has funded our 5-year research project. The overarching aim of this study is to acquire experimental data to inform possible recommendations to refine management techniques. A combination of field and modelling work will identify those management or restoration options of greatest cost-benefit to restoring 'active' peatland and the associated ecosystem services. The field experiments will compare 'control' to 'treatment' areas at three instrumented sites, two in Yorkshire in collaboration with the Yorkshire Peat Partnership, Nidderdale and Mossdale, and another in the Forest of Bowland (United Utilities).

[Picture: site setup]

We have established, at each of the three field sites, two adjacent sub-catchment scale experimental sites: the 'control sub-catchment' and the 'treatment sub-catchment'. Within the treatment sub-catchment, mowing and other alternatives will replace the 'business as usual' burning to be continued in the control sub-catchment. Four monitoring areas will be set up within each of the two sub-catchments at each of the three field sites. This replication within and across sites will allow rigorous statistical analysis of

management effects on key ecosystem parameters. The following parameters will be monitored alongside meteorological variables: carbon stocks, CO_2 fluxes, CH_4 emissions, peat pipes, vegetation dynamics, water balance and water quality and modelling will allow up-scaling of the findings in space and time, thus making results applicable beyond the experimental sites.

[Picture: experimental design]



The management of heather-dominated blanket bogs highlights some of the challenges involved in managing complex systems for the benefit of landowners, managers and society. Finding the best way forward relies on robust evidence, a shared understanding of the problems and a willingness to engage with other points of view and search for solutions. I am looking forward to a constructive engagement with the key stakeholder groups involved in the active and policy related management of these beautiful places. I have always been of the opinion that clear evidence of impacts will help to inform such discussions, and I see this Defra research as a key input to that process.

I would like to conclude with one of Simon Thorp's blog entries (13th April, 2012): "My test for success is to stand overlooking an area of uplands and to ask (1) have we got this right? If not (as is most often the case) the next questions are: (2) what do we want to do about it and (3) what is stopping us?". I hope I will be able to report back on this project in a few years with an indication to move into the 'yes' direction (having addressed these three pivotal questions).