MANCHESTER 1824
The University of Manchester

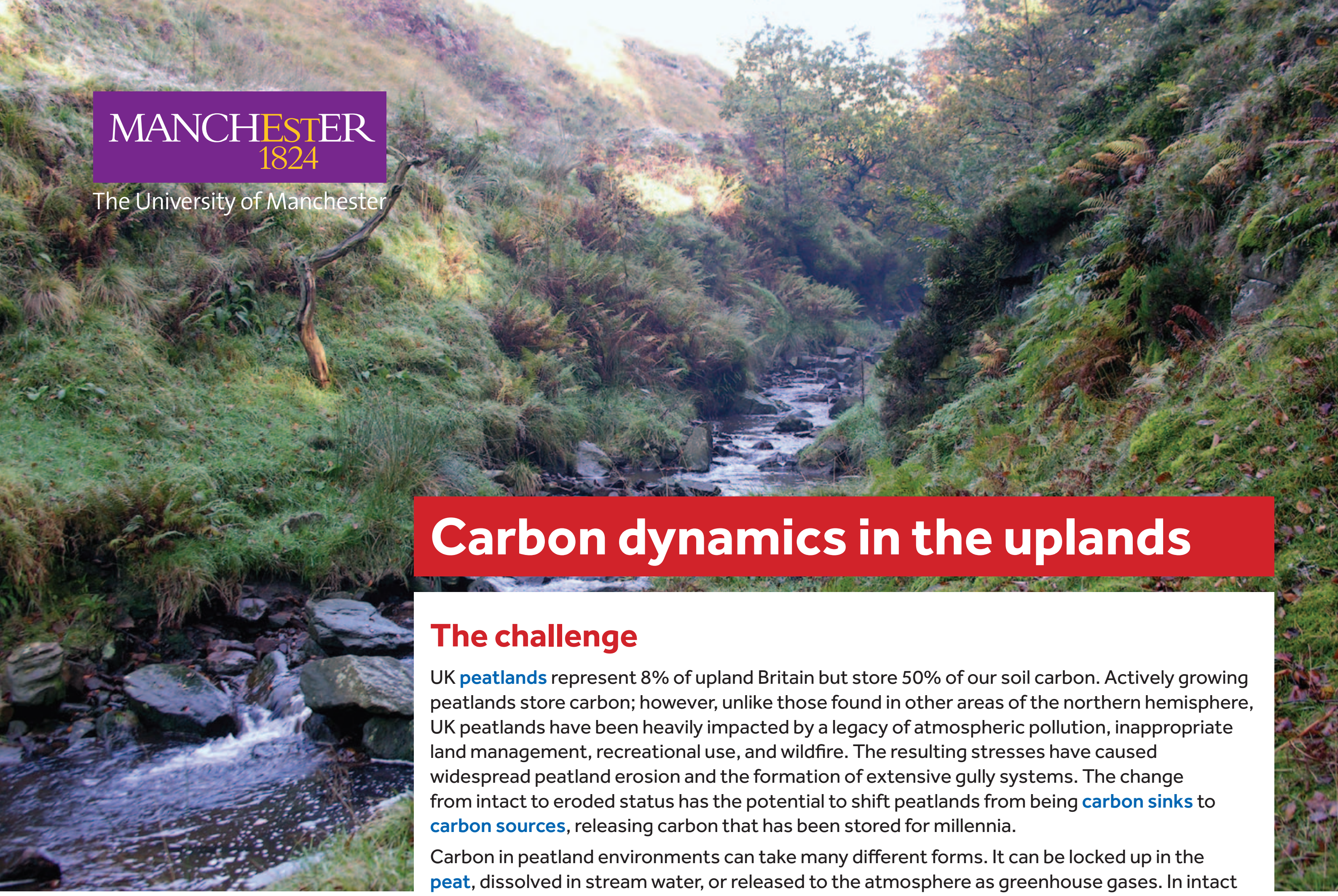

Photo: Janina Holubecki

Carbon dynamics in the uplands

The challenge

UK **peatlands** represent 8% of upland Britain but store 50% of our soil carbon. Actively growing peatlands store carbon; however, unlike those found in other areas of the northern hemisphere, UK peatlands have been heavily impacted by a legacy of atmospheric pollution, inappropriate land management, recreational use, and wildfire. The resulting stresses have caused widespread peatland erosion and the formation of extensive gully systems. The change from intact to eroded status has the potential to shift peatlands from being **carbon sinks** to **carbon sources**, releasing carbon that has been stored for millennia.

Carbon in peatland environments can take many different forms. It can be locked up in the **peat**, dissolved in stream water, or released to the atmosphere as greenhouse gases. In intact peatlands, high water tables limit the decomposition of plant material, so that peat accumulates and carbon is stored. However, gully erosion has the potential to change this. Gullying lowers **water tables**, allowing decomposition of the peat, which releases carbon to the atmosphere and rivers. These gullies also rapidly move eroded peat into the stream network.

Once in the stream system, this material is known as particulate organic carbon (POC), and can be redeposited, either to sites of long-term storage such as reservoirs and oceans, or other areas such as floodplains where it can be oxidised to the atmosphere. While it is being transported in rivers, it can also be oxidised or it can be transformed to other forms of carbon such as dissolved organic carbon (DOC). Increased DOC concentrations can lead to a brown discolouration in water, which can be costly to remove and present a major water treatment issue. In addition to this, DOC can transport heavy metals.

Peat erosion may become more widespread under predicted climate change. This means that there is a pressing need to understand the impacts of erosion on peatland carbon balance, and consequently any potential feedbacks to atmospheric carbon levels. Better understanding of these fragile systems allows us to inform land managers about best practice for the reduction of erosion. This, in turn, improves carbon storage.

> **"There is a risk that peatland degradation in a warmer world will create positive feedback in the climate system releasing more carbon to the atmosphere. To mitigate this risk we need to continue to develop our understanding of the peatland carbon cycle and peatland restoration."**
>
> *– Professor Martin Evans*

Our research

The carbon research undertaken by peatland scientists at the University of Manchester is diverse, involving laboratory experiments, extensive field campaigns at study areas in the **Peak District** National Park in the southern **Pennines**, and computer modelling. It includes the following areas:

- Establishing carbon balance of peatlands;
- Identifying the key controls on carbon export;
- Developing new methods to map gullies;
- Examining the effects of restoration on carbon dynamics;
- Exploring the controls on transformations of carbon in river systems;
- Investigating the causes of DOC release into upland rivers;
- Assessing the short- and long-term impact of land management practices such as burning and grazing on upland carbon stocks.

Environmental Processes Research Group

http://www.seed.manchester.ac.uk/subjects/geography/research/research-groups/eprg/

Photo: Gareth Clay

"Land management activities can have a range of impacts on carbon: inappropriate management can damage these sensitive areas, but sustainable management practices have the potential to limit carbon losses, or even lead to carbon gains. By working with stakeholders, we can study the effects of different land management practices to help improve peatland carbon storage."

– Dr Gareth Clay

Current findings

Our research has focussed on the various ways carbon can be gained or lost from peat. For example, we have shown that the presence of vegetation in different parts of a gully accounts for significant variations in gaseous carbon dioxide (CO_2) flux. Carbon can also be lost through rivers. We have shown that the severely eroded peatland catchment associated with the River Ashop is a carbon source, and the dominant form of carbon in the river was POC.

Combining all the carbon pathways together in a 'carbon budget' allows us to establish whether the peat is a carbon sink or carbon source. These budgets can vary between individual peatlands. For example, when looking the entire Peak District region, modelling studies have shown that the area is a net sink of 62,000 tonnes CO_2/year. However, the severely eroded peatlands of the Bleaklow Plateau have turned from a net carbon sink to a net source. So, whilst some sites are currently carbon sinks, upland peats in the UK are predicted to become increasing source of carbon in the future. If management interventions were targeted across the area, the total sink could increase to 162,000 tonnes CO_2/yr. We have worked on producing current and future carbon budgets with colleagues from the University of Durham.

The team at Manchester also work closely with land managers and conservation organisations such as the Moors for the Future Partnership (MFFP) to understand the role of fire on peatland carbon budgets. Fire produces carbon-rich charcoal and we estimate that up to 125 tonnes of black carbon are produced in the Peak District every year, through both wildfires and prescribed burning. Ongoing research is looking at the role of prescribed burning on DOC in peat waters.

In recent years, the MFFP has worked to restore large areas of the Peak District National Park, through re-vegetation and gully blocking. We have worked in partnership with MFFP to evidence the impact of these interventions. Our work has shown that re-vegetation stabilises bare surfaces, preventing POC from being washed into the stream system. We have also shown that restoration brings water tables closer to the peat surface, which may limit the losses of carbon in the upper peat. Both these effects will improve the carbon storage ability of these systems.

Peatland carbon research at the University of Manchester is diverse, but there is agreement that future climate change will threaten the carbon status of these vulnerable ecosystems. Mitigation of these effects depends on local management and restoration, informed by an understanding of the processes controlling carbon dynamics in peatlands.

Further information

Please see related publications produced by our researchers.