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Pollutants in the Peat

From sink to source

Photo: Janina Holubecki

> **Peatlands have the ability to store significant levels of atmospheric pollution, but degradation of this important ecosystem can mobilise historic metals into the contemporary environment.**
>
> *– Dr James Rothwell*

The challenge

The **peatlands** of the **Peak District**, in the southern **Pennines**, are located in the heartland of the English Industrial Revolution, between the cities of Manchester and Sheffield. Over the last few hundred years, these peatlands have become contaminated by atmospheric pollution related to industry, transport, and power generation. Now deposited within their upper layer is a store of heavy metals such as lead, copper, zinc, nickel, and arsenic.

The peatlands in the Peak District are some of the most heavily contaminated peatlands globally, and are the most severely eroded in the UK. Loss of vegetation, due to human pressures and changes in climate, has resulted in bare surfaces which are subject to intensive erosion. The **peat** is eroded by rainfall and wind, and is washed into nearby streams. The contaminants stored in the 'dirty' peat layer, which were previously 'locked up', are released into the river system.

By eroding the contaminated peat, the degradation of the peatlands has turned this area from a sink, or store, of contaminants to a source – releasing them into the environment. Future climate change, resulting in higher summer temperatures and stormier winters, may increase the likelihood of such erosion, and peatlands elsewhere may experience the kind of erosion seen in the Peak District in the future.

Many headwater streams of the Peak District recharge drinking water reservoirs. Such streams are acidic due to the organic acids produced by the breakdown of vegetation in the peatlands. Once released into the river, interactions between the contaminated sediment and the acidic stream water can transform metals from a solid to dissolved state, which makes their release more of a concern. If the toxic metals that were previously 'locked-up' in the peat enter the river system, they may affect drinking water quality. In addition, some of the contaminants are toxic to aquatic ecosystems at even low concentrations, so there is a potential threat to downstream ecology.

Our research

Understanding the level of contamination, the processes that release metals into streams and how these processes may be changed during peatland erosion is important from both management and conservation perspectives. Our research has highlighted some of the key challenges relating to the legacy of our industrial past.

Research at the University of Manchester on metal storage and release in eroding peatlands has formed several strands including:

- Development of methods to assess the storage and release of contaminants;
- Quantifying the amount of metals stored near the peat's surface;
- Looking at the variability in storage within single peatlands, and between peatlands;
- Assessing the mobility of metals within the peat column;
- Investigating the release and transformation of metals into the river system;
- Examining the effect of peatland restoration on metal release.

Environmental Processes Research Group
http://www.seed.manchester.ac.uk/subjects/geography/research/research-groups/eprg/

Photo: Janina Holubecki

> **While not ideal, the pollution stored in the peatlands of the Peak District can be exploited to trace the movements of eroded material. This offers us a unique opportunity to better understand the processes that shape these vulnerable landscapes, aiding conservation efforts to preserve them for future generations.**

– Dr Emma Shuttleworth

Research has often been heavily focused on lead as it is less mobile in the peat than other elements. This makes it easier to study the impacts of change over time. Furthermore, due to lead's high toxicity, there has been an urgent need to understand the processes leading to its release and its transport and distribution pathways. Both field and laboratory approaches undertaken by our researchers have helped to unravel the links between the erosion of contaminated peat and the subsequent fate of the released lead.

Current findings

Our research has found that high concentrations of lead are stored near the peat's surface, and that erosion is releasing large quantities of lead into river courses. Organic matter has been found to be the principle carrier for lead in the rivers that drain peatlands. We have demonstrated that both physical and chemical processes elevate the concentrations of dissolved metals in these acidic environments.

We have discovered that the lead content of river sediments can vary considerably. This could be due to several reasons, including differences in the organic matter content of the sediment; and differences in the proportion of the amount of 'dirty' and 'clean' sediment eroded from gully walls, which in turn are linked to eroded gully depth. There is also evidence to suggest that under certain environmental conditions, large quantities of lead are released early in storm events as an initial 'flush' of contaminated material into streams.

We have also carried out research on the restoration of eroding gullies and how this affects lead release. Re-vegetation stabilised the peat's surface; thus preventing the release of contaminated sediment and reducing lead concentrations in streamwater to levels equal to, or below, those in areas of peatland which have experienced no erosion. This has positive consequences for downstream water quality, and provides validation for the re-vegetation that has been pioneered in the Peak District by the Moors for the Future Partnership.

The wide scope of our research is beneficial in analysing what may happen to these peatlands in future, particularly under future climate change scenarios. We have used our findings to model landscape-scale lead storage and release, in order to better understand the key processes that are driving lead release in these areas. Our current knowledge and understanding will aid the management and restoration of this fragile landscape, but the extent to which these issues will present a problem in other peatlands requires further research.

Further information

Please see related publications produced by our researchers.