

Heavy Metal Pollution in Eroding Peak District Moors

Industrial Legacy

- High concentrations of industrially derived, atmospherically transported heavy metals are stored in the upper peat layer of the blanket peats of the Peak District. Peak lead (Pb) concentrations in the Peak District moorlands can exceed double the Defra guidance value for contaminated industrial land.

Water Quality

- The flux of heavy metal pollutants from peatlands is of importance not only to the ecology of aquatic ecosystems but also to the quality of drinking water collected in the many moorland reservoirs.

The Project

- Supported by Moors for the Future, this study provides a detailed assessment of the problems associated with contamination of blanket peat catchments of the Peak District.



Water sampling site.



Severe erosion on Bleaklow

Location	Pb (mg kg ⁻¹) maximum
Alport Moor, Derbyshire, England*	1647
Ringinglow Bog, Derbyshire, England*	1230
Forest-steppe zone, southern Russian Plain	856
Tinsley Park, Bog, Sheffield, England	827
Grassington Moor, Yorkshire, England	800
Ringinglow Bog, Derbyshire, England*	700
Snake Pass, Derbyshire, England*	570
Ringinglow Bog, Derbyshire, England*	548
Kola Peninsula, Russian Arctic	510
Bozi Dar, Czech Republic	479
Lochnagar, Scotland	400
Tor Royal, central Dartmoor, England	400
Flanders Moss, central Scotland	388
Northern Black Forest, southern Germany	339
Langmoos Bog, Mondsee, Austria	230
Hajavalta, southwest Finland	204
Ystwyth valley, Wales	200
Canton Jura, Switzerland	120
Penido Vello, northwest Spain	84
Point Escuminac, eastern Canada	53
Stokkanmyra Bog, Trondheim, Norway	50

Table 1. Maximum lead (Pb) concentrations in a selection of peatland environments (* sites in Peak District, several studies)



Trap positioned at the base of the gully wall.

Global Picture

- When comparing the Peak District moorlands with other peatlands that receive their contaminant inputs from diffuse sources, they are amongst the most contaminated in the world (Table 1).

Flux of Heavy Metal Pollution

- Two catchments were studied, one representing an area dominated by gully erosion (Upper North Grain) and one representing large areas of bare peat (Torside Clough).

Methods

Upper North Grain

- 8 peat cores with good spatial coverage were taken from the catchment and analysed for Pb content.
- Gully wall traps were fixed to investigate Pb flux from a gully face.
- Mats were used to trap overbank sediment deposition during storm events and analysed for Pb content.
- Two automatic water samplers were placed at 2 different stream locations and programmed to collect 24 samples during storm events.

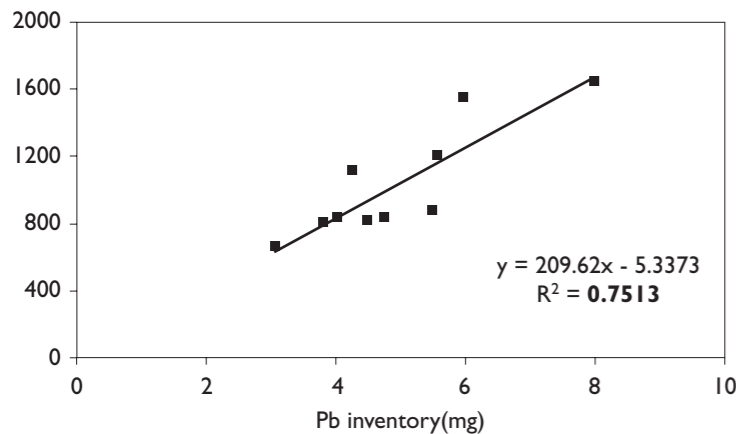
Torside Clough

- Another automatic water sampler was set up to collect water samples during storm events.

Pb Inventory

- Work was also carried out to investigate the small scale variability of Pb contamination in peatland environments. In total, 48 cores were taken from Alport Moor to be used for analysis to compare the pros and cons of measuring contamination by peak concentration and by inventory. It was found that peak Pb concentrations vary significantly over small spatial scales, and therefore heavy metal inventories, rather than concentrations on a depth basis, are more accurate for assessing contamination status of peatland areas and providing information on total metal stores.

- However, peak Pb concentrations can be useful for assessing pollution status of a site if small scale variability can be quantified. It was found that Pb inventory provided a reasonable proxy for Pb peak value.



Linear regression of Pb inventory of the top 9 cm and Pb peak for the Alport Moor peat cores.

Solid Phase Pb Content

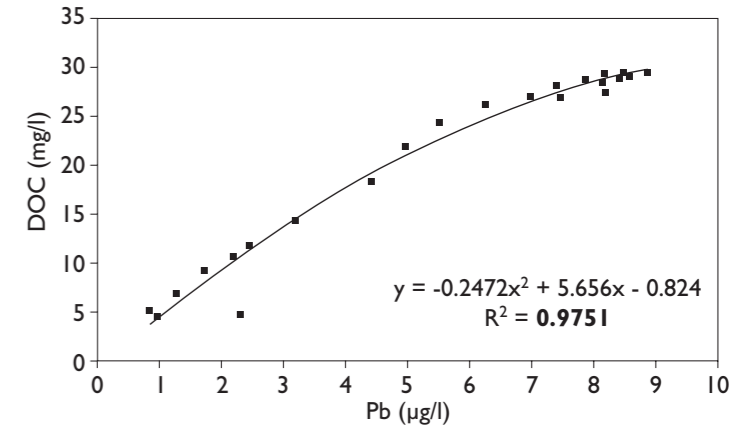
- All suspended sediments collected from all 3 sites were contaminated with Pb.
- At Upper North Grain, mean sediment-associated Pb values were higher at the Upper Weir than at the Main Weir. This is attributed to high organic content of the eroded source area at the upper weir and proportionally less "clean" peat at this site due to shallow gully incision.
- Because of the bare peat flats at Torside Clough, mean sediment-associated Pb concentrations were expected to be higher than at the other sites. However, this was not the case. This may be attributed to historical erosion in the Torside Clough catchment already having removed much of the contaminated peat layer.

Dissolved Phase Pb Content

- In the storm events sampled there was a strong positive correlation between Pb and dissolved organic carbon, indicating that dissolved organic carbon is effectively mobilising and transporting Pb in the fluvial system.

	TORSIDE CLOUGH	UNG MAIN WEIR	UNG UPPER WEIR
Mean	113.99	102.53	137.62
StDev	35.20	38.96	32.53
Min	22.94	4.43	77.43
Max	205.48	392.64	240.38
n	162	212	94
CL (95%)	5.46	5.28	6.66

Descriptive statistics for sediment-associated Pb values for storm events collected from the study catchments.

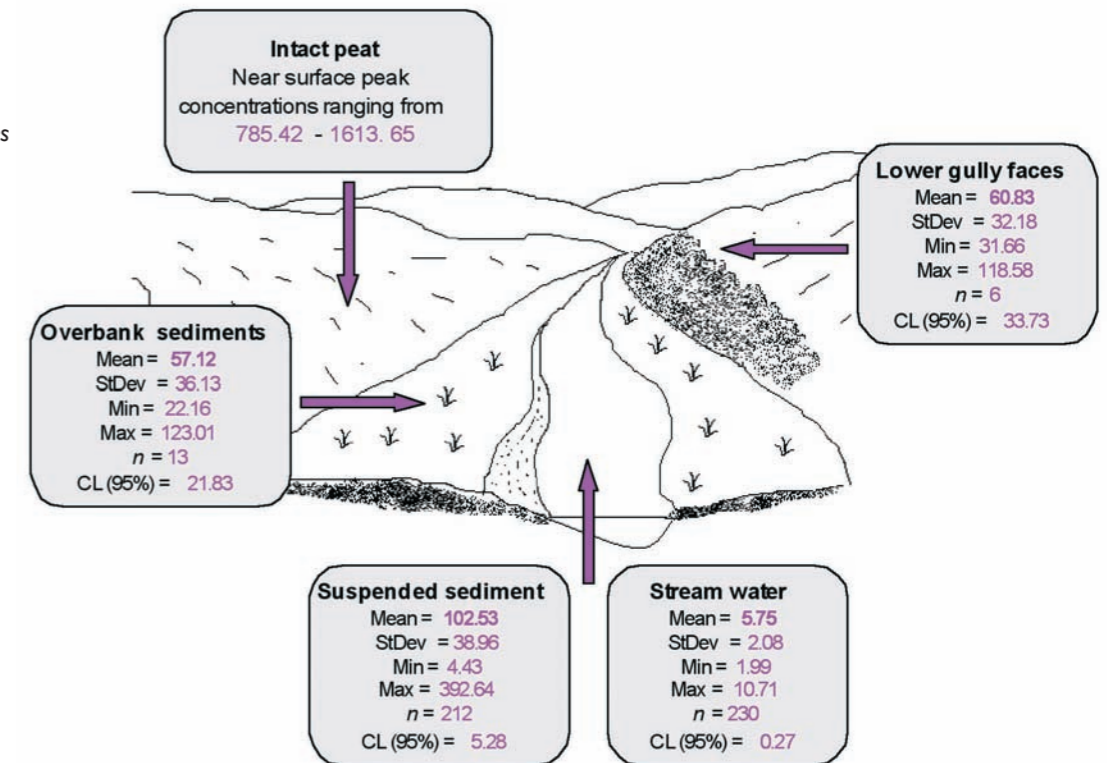


Relationship between Pb and dissolved organic carbon for an autumn 2004 storm event collected from Upper North Grain (Main Weir).

Lead (Pb) in the sediment-water system at Upper North Grain

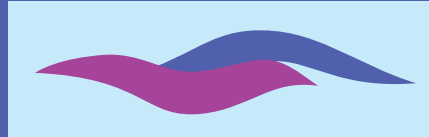
Pb concentrations for sediments in mg kg⁻¹ and dissolved concentrations in µg l⁻¹.

Suspended sediment and dissolved concentrations are based on data from the Main Weir.



Autumn Flush

- During summer months of water table drawdown, reduced precipitation and higher temperatures, dissolved organic carbon is generated within peatland environments. During the early autumn dissolved organic carbon is flushed out of the peat with the onset of precipitation and a rise in water table. During such times, the mobilisation of lead by dissolved organic carbon is particularly prevalent.



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Acknowledgements / Data availability

- The research was conducted by James Rothwell, Martin Evans and Tim Allott from The University of Manchester. Copyright of all data and maps remains with the authors.
- Copies of the research reports are held in the Moors for the Future library.
- Views expressed in this research note do not necessarily reflect those of all Moors for the Future Partners.

References / Links

Rothwell, JJ (2005) Flux of heavy metal pollution from eroding southern Pennine peatlands. Unpublished report, The University of Manchester.

Rothwell, JJ, SG Robinson, MG Evans, J Yang, TEH Allott (2005) Heavy metal release by peat erosion in the Peak District, Southern Pennines, UK. *Hydrological Processes*, 19, 2973-2989.

www.sed.manchester.ac.uk/geography/research/uperu/

Moors for the Future Research notes

No 1 Breeding Bird Survey of the Peak District Moorlands

No 2 Gully Blocking in Deep Peat

No 3 Peak District Moorland Stream Survey

No 4 Heavy Metal Pollution in Eroding Peak District Moorlands

No 5 Visitors on Peak District Moorlands

No 6 Rapid Assessment Protocol for Monitoring Burning

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The Moors for the Future Partners are:

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