Annex 5

Sediment accumulation trajectories on bare peat stabilisation sites

Prepared by

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Sediment Accumulation Trajectories on Gully-Blocking Sites

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1. Summary

Dense networks of deeply incised gullies are the result of severe erosion in degraded blanket bog sites in the South Pennines. These channels create highly efficient drainage networks for the transport of runoff in storm events, and eroded sediment from the peat surface. Gully-blocking has been undertaken at the landscape scale, with the intention of slowing the velocity of storm runoff, raising water tables in the surrounding peat, and trapping sediment.

This report assesses the efficacy of gully-blocking, in relation to trapping sediment, thereby reducing carbon export from the peatlands. Data were collected by Moors for the Future Partnership (MFFP) by monitoring sediment depth change as a result of installing gully blocks using a range of materials. Analysis of these data shows that all types of gully blocks monitored successfully trap sediment during the first two years after installation. Insufficient data were available to draw reliable conclusions as to the relative successes of each type of gully block. Long-term data were not available, and are required in order to assess the scale and longevity of the impact of gully blocking on sediment accumulation.

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2. Introduction

2.1. Peatland Degradation

A combination of human and natural influences has led to severe degradation of peatlands in the uplands of the South Pennines (Tallis, 1998). Widespread erosion and loss of vegetation cover have led to the presence of large expanses of bare peat and deeply incised gully networks. Subsequent drying of the peat mass restricted the possibility of vegetation recovery and increased rates of erosion. These conditions have led to increased concentrations of dissolved and particulate organic carbon and other nutrients or pollutants in the waters draining from these headwater catchments (Bussell *et al*., 2010), with financial implications for utility companies removing these substances from drinking water supplies (Wallage *et al*., 2006), as well as the environmental impacts on the global carbon cycle due to fluvial conversions of dissolved organic carbon (DOC) to carbon dioxide (CO_2).

2.2. Peatland Restoration

Peatland restoration has been undertaken at the landscape scale in the South Pennines, and has included extensive blocking of erosion gullies and artificially dug drainage grips. The types of dam installed fall into two broad categories:

- Impermeable dams, made using either plastic sheet or peat excavated from on-site, are designed to trap water to create pools (and raise the water table).
- Permeable dams, made using heather bales, piles of stones or logs, or planks of timber with small gaps, are designed to trap sediment, which will build up soil on the gully floor to be re-vegetated. They also slow (but not stop) the water flow, allowing water to drain slowly down the channel during low-flow conditions. The water storage capacity thus created, delays the flow of stormwater to the river networks downstream and reduces flood risk.

3. Aims

The efficacy of gully-blocking for achieving the outcomes of raising water tables and reducing stormflow peaks is reported in Allott *et al.* (2015). The aims of this report are to:

- Investigate the efficacy of different gully-blocking techniques for trapping and accumulating sediment suspended in streamflow in eroding peatland catchments.
- Create baseline data from which it may be possible to create trajectories of sediment accumulation in future years.

4. Data Sources

This report is based on sediment accumulation data collected and supplied by the MFFP on peatland restoration sites across the South Pennines between 2012 and 2015, as part of the Peatland Restoration Project (PRP) and Woodhead Gully Block Monitoring Project (WGBM).

5. Methodology

Sediment depth was measured 1m upstream of newly installed gully blocks (constructed using logs, overlap timber or stone) in 2012 (WGBM) and 2013 (PRP), as soon after installation as logistically possible. Repeat surveys were then carried out in the following two years, with measurements taken in as close to the same precise location as possible. For comparison, surveys were also carried out in unblocked gullies, both in eroding systems, and in intact systems. Sample sizes are indicated in Table 1.

Gully block	2012	2013	2014	2015
Overlap timber (PRP)	0	26	26	26
Log (PRP)	0	59	29	29
Stone (PRP)	0	107	78	0
Stone (WGBM)	50	50	50	0
No block (intact, PRP)	0	45	45	0
No block (eroding, PRP)	0	90	90	0
No block (eroding, WGBM)	20	20	20	0
Total	**70**	**397**	**338**	**55**

Table 1: sample size for sediment surveys

6. Results

Results of the sediment accumulation surveys are presented here as change from initial survey. Each measurement in year “1” (one year after installation of gully blocks) and year “2” (two years after installation of gully blocks) is compared to the equivalent measurement from the same location in year “0” (immediately following installation of gully blocks). Negative values represent erosion of sediment from the measurement location; positive values represent accumulation.

An overview of the effect of blocking gullies with a combination of dam-types is demonstrated in Figure 1. Data are categorised as ‘blocked’, ‘unblocked control’ and ‘intact reference’, and annual means (combined from results from stone, timber and log dams – all designed with the intention of trapping sediment) are presented, with error bars displaying one standard error of the mean.

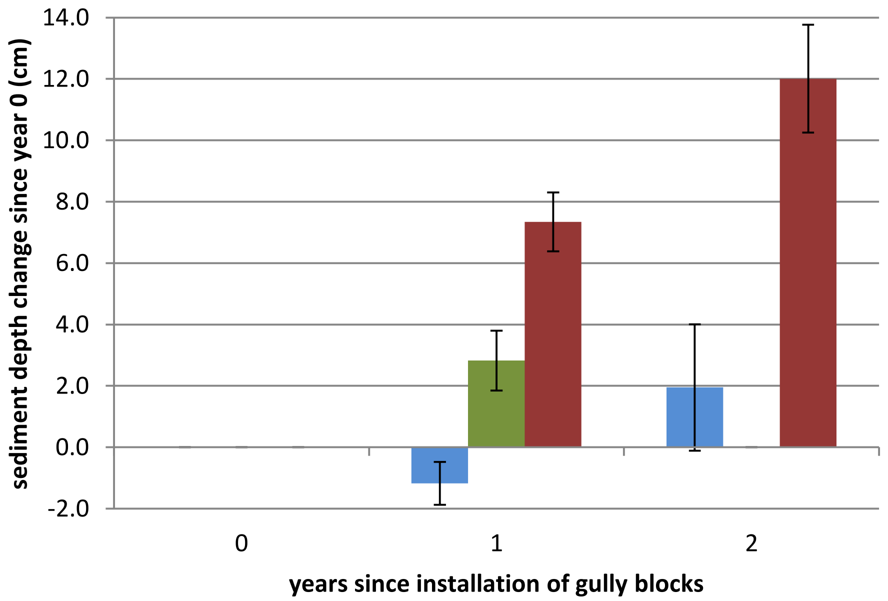

Figure 1: Annual mean sediment accumulation/erosion in gullies in the South Pennines.

Error bars represent 1 standard error of the mean. ■ = unblocked control, ■ = intact reference, ■ = blocked

Across all three projects, a mean of 7.3cm of sediment accumulated 1m upstream of gully blocks in the first year after installation. A further 4.7cm accumulated in the following year. By comparison, an average of 2.8cm accumulated in the first year in intact reference locations, where no blocks were installed, and 1.2cm of peat was eroded from unblocked control locations in eroding systems.

The data from the blocked gullies are presented below having been further categorised into different types of dam. As shown in Figure 2**Error! Reference source not found.**, overlap timber, log and stone dams all accumulated more sediment than was observed at intact reference sites in the first year after installation. In the second year, results suggest that log dams on average accumulated a further 5.9cm of sediment, while overlap timber dams lost 1.2cm of sediment through erosion. The error bars indicate high levels of uncertainty, most notably in the overlap timber dam data, in both years following dam installation. These results should therefore be treated with caution. No data were available for stone dams in the second year after installation.

The stone dams at the WGBM sites accumulated 14.3cm in the first year after installation, noticeably more than those at the PRP sites (4.2cm), and also noticeably more than any of the different gully block designs at the PRP sites.

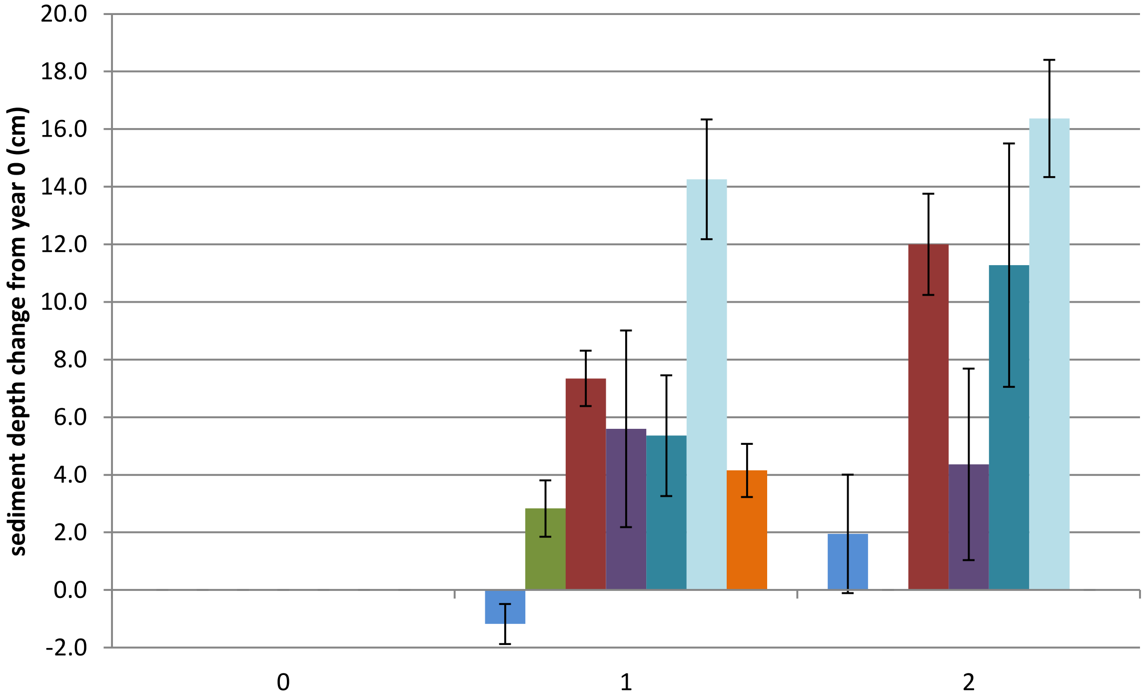

Figure 2: Annual mean sediment accumulation at gullies blocked with a range of dam types.

Error bars represent 1 standard error of the mean. ■ = unblocked control, ■ = intact reference, ■ = all blocked, ■ = overlap timber dam, ■ = log dam, ■ = stone dam (WGBM) ■ = stone dam (PRP)

7. Discussion

The results presented here suggest that gully-blocking methods including overlap timber, log and stone dams are effective at trapping sediment suspended in streamwater in eroding peatland catchments, accumulating an average of 6cm/year of sediment 1m upstream of the installed block over the first two years after installation.

The relative efficacy of the different methods used is unclear, due to high levels of uncertainty in the available data. Results from stone dam sediment surveys differ noticeably between projects, with dams at WGBM sites apparently accumulating over 10cm more sediment than at PRP sites in the first year. This may be due to differences in the amount of time between installation of dams and the year 0 surveys, with longer delays before the PRP surveys than the WGBM surveys. Sediment may begin to accumulate behind dams immediately following installation, potentially in part as a result of disturbance to the peat surface during treatment works, and therefore the longer the delay before the initial survey, the smaller the recorded change from initial values after the first year (Crouch *et al.*, 2015).

More in-depth analysis and discussion of these datasets has been reported in Crouch *et al*. (2015) and Maskill *et al.* (2015).

The methods used do not allow accurate estimation of the total volume of sediment accumulated, as the measurements are from single locations, and peat may accumulate at different rates in different parts of the gully behind the dam. For estimations of total volume of accumulated peat, a more appropriate method would be to use LiDAR data, as presented in Crouch *et al*. (2015).

Given the lack of long-term data, it is not appropriate to construct linear trajectories of sediment accumulation from the current datasets, although results demonstrate that all dam types monitored effectively accumulate sediment over the first two years after installation. It is recommended that monitoring is continued in future years, by repeating sediment surveys in the same locations as previously, at all three dam types. If these data are collected, the existing data will provide valuable baseline data from which trajectories may be extended. These long-term data may also provide valuable information regarding the 'lifecycle' of the dams, as, once a dam is 'full', it may no longer be able to accumulate sediment, and may require 'topping up'.

8. References

Allott, T., Shuttleworth, E., Evans, M., Agnew, C., Pilkington, M.G., Spencer, T., Milledge, D., Gorham, J., Mellor, J., Jones, A., Richards, R., Maskill, R., & Walker, J. (2015). *Annex 5: Flood Risk.* In Pilkington M.G. et al. (2015) *Restoration of Blanket bogs; flood risk reduction and other ecosystem benefits.* Final report of the Making Space for Water project: Moors for the Future Partnership, Edale.

Bussell, J., Jones, D., Healey, J., Pullin, A. (2010). How do draining and re-wetting affect carbon stores and greenhouse gas fluxes in peatland soils. *CEE Rev*. 08-012.

Crouch, T., Walker, J.S. and Morley, K. (2015). Peatland Restoration Project: Rivers Alport and Ashop Monitoring Report. Moors for the Future Partnership, Edale.

Maskill, R., Walker, J.S., Benson, J., Allott, T., Evans, M. and Shuttleworth, E. (2015). Woodhead Gully Block Monitoring: Final Report. Moors for the Future Partnership, Edale.

Tallis, J.H. (1998). Growth and degradation of British and Irish blanket mires. *Environ. Rev. 6*, 81–122.

Wallage, Z.E., Holden, J., McDonald, A.T. (2006). Drain blocking: An effective treatment for reducing dissolved organic carbon loss and water discolouration in a drained peatland. *Sci. Total Environ.* 367, 811–821.