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Drain-blocking techniques on blanket peat: A framework for best practice

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ABSTRACT

In recent years there has been a dramatic increase in artificial drain-blocking in world peatlands. The UK blanket peatlands have been severely drained over the past few decades but now drains are being blocked in an attempt to improve peatland environments. The drain-blocking has been a disparate process with limited knowledge transfer between organisations and within organisations operating in different geographic areas. Consequently, there has been no compilation of techniques used and their effectiveness. During this study thirty-two drain-blocked sites were surveyed and all the key stakeholders interviewed. Drain-blocking using peat turf was preferred by practitioners and was also the most cost-effective method. Peat turves were successful except on steep slopes, in areas of severe erosion, in very wet or very dry locations, or if the mineral substrate was exposed. A drain-blocking best practice guide is offered by this paper, providing information on the most suitable methods for blocking peatland drains under different circumstances. Additional considerations are provided for practitioners to ensure peatland drain-blocking is as successful as possible.

1. Introduction

The uplands of the UK are dominated by organic soils and particularly by blanket peat. A large proportion of UK peatlands have been drained. Drainage typically involved open cut ditches around 50 cm deep and 50–70 cm wide. The drains are often linked in herringbone shapes or follow the contour of the hillslope before flowing into an escape drain which connects to a stream. Drainage records in the UK predate Roman times (Darby, 1956) but there was a dramatic increase in peatland drainage after the Second World War as a result of government grants (Robinson and Armstrong, 1988). The peatlands were drained in order to increase food production in the uplands by improving the land for sheep and grouse. However, there is no evidence that peat drainage fulfilled the land improvement aims set (Stewart and Lance, 1983; Holden et al., 2007b) and several other negative impacts of drainage have been a cause of concern. For example, changes in river flow regimes (Holden et al., 2004, 2006; Robinson and Armstrong, 1988); erosion of the ditches (Mayfield and Pearson, 1972; Holden et al., 2007a); changes in the peat structure (Minkkinen and Laine, 1998; Holden, 2006); increased aerobic decomposition as a result of the lowered water table (Clymo, 1987; De Mars et al., 1996; Shantz and Price, 2006); and increased leaching of nutrients (Sallantaus, 1995; Holden et al., 2004) (Clausen, 1980; Mitchell, 1990; Mitchell and McDonald, 1992). Furthermore, peatlands are important carbon stores which, when actively forming, can sequester large volumes of carbon from the atmosphere (Waddington and Price, 2000; Blodau, 2002; Frolking et al., 2006). Consequently, there is a growing realisation that peatland drainage is locally and globally detrimental (Holden et al., 2004). These factors, coupled with the UK legislative requirement to ensure many upland peatland habitats are in a favourable condition (Holden et al., 2007b), have led to wide-scale blocking of the drains. The principal rationale for drain-blocking in UK varies between stakeholders but in most instances it is water table recovery that is the objective in order to encourage more peat forming species to establish. Other aims, or added benefits are reduction of dissolved organic carbon flux and reduced sediment transfer and erosion. Consequently, regardless of the motivation for drain-blocking at a site it is desirable to create a watertight dam: if there is no flow then the water table rises, there is no sediment loss, dissolved organic carbon loss is generally decreased (Armstrong et al., in preparation), and pool environments are created which are ecologically beneficial.

The first upland peat drain dams in the UK were installed in Caithness, Scotland, in the late 1980s and there has been a dramatic increase in blocking during the last five years throughout the UK. Complete infilling of peat drains is rare and more commonly drain-blocking occurs through the installation of dams at intervals along the length of each drain. The drain-blocking has been instigated by

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various stakeholders using a range of techniques. We estimate that more than €250 million has been spent on peatland drain-blocking in the UK to-date; however, there has not been a comprehensive review of techniques and their effectiveness. Furthermore, there is little documentation detailing how to prioritise catchments for blocking, which type of dam technique or material to use, where to block at the site, and drain scale or other factors which should be considered when establishing a drain-blocking plan. This paper aims to evaluate dams that have been installed into peatland drains in order to establish a basis for future investment in dam installation and to provide a drain-blocking best practice framework for stakeholders.

Our work on drains should not be confused with very different needs that may be required where large gullies have developed under natural or anthropogenically forced conditions. Many peat gullies can be several metres deep and several metres wide and hence the damming process requires quite different solutions in many cases. Evans et al. (2005) showed that for such deep wide gullies wooden fencing, plastic piling and stone walls were all effective gully blocking methods. They also showed that block spacing should not exceed 4 m and minimum spacings could be derived as a function of gully depth. The target height of a gully block should be 45 cm while 25 cm should be a minimum height. This means that in most cases the dams in the gully do not raise water tables to the natural surrounding peat surface as a 45 cm block in a several metre deep gully is designed to stabilise the sediment and allow progressive deposition and revegetation of the gully floor. It was also found by Evans et al. (2005) that for peat gullies maximum block widths should not exceed 4 m and that planting of blocks with *Eriophorum angustifolium* once stable sedimentation has been achieved may aid peat stabilisation.

2. Field sites and survey design

Thirty-two UK sites (Fig. 1) were sampled with a total of 278 blocked drains evaluated. The sites were identified by contacting relevant stakeholders such as Natural England, Scottish Natural Heritage, Countryside Council for Wales and National Park authorities. The drains were surveyed for morphological variables (including slope), surrounding peat wetness, exposure of the substrate, drain dimensions, and dam effectiveness, material type and construction design. Dam effectiveness was evaluated in a quasi-quantitative way by using a score sheet as shown in Table 1. The wetness of ground around each drain surveyed was scored as either wet (soft, bubble like, surface moves by >2 cm when you walk on it), intermediate (water visible if you jump), or dry (firm underfoot, no water when you jump). These scoring techniques were adopted as the survey needed to be rapid and summarise the conditions in a way which could be easily compared, thus the simplifications are justified. In addition to surveying the drains, each site contact and any additional stakeholders (including contractors, farmers, gamekeepers and representatives from the RSPB, Natural England, Countryside Council for Wales, Scottish Natural Heritage, Environment Agency and National Park staff) were interviewed using semi-structured interviews to build up knowledge of the practical considerations and concerns relating to drain-blocking. The results of the stakeholder interviews are reported qualitatively in this paper by providing an overview of opinions presented and maintaining anonymity as agreed with the stakeholders.

3. Field results

3.1. Dam construction

The materials used to construct the peat drain dams were predominantly heather bales (cut heather rolled into cylindrical bales approximately 50 cm in diameter by 75 cm tall), peat turves, plastic piling, corrugated Perspex (a smooth plastic with ~60 mm profile), plywood, wooden planks, stones and combinations of these materials on the same dam or same drain (Fig. 2). There were some variations in the installation of the dam blocks at different sites as outlined in Table 2. Peat turves, plastic piles, corrugated Perspex, plywood dams and wooden plank dams all aimed to create a watertight seal whereas heather bales aimed to decrease flow velocities, trap sediment and eventually result in drain infilling (although creating a watertight seal is the most effective method to reduce sediment transfer). In addition to the above methods found during the field survey, stakeholders had also trialled straw bales and sheep wool in Hessian sacks. However, straw bales failed rapidly and there were concerns regarding the introduction of foreign seed and nutrients and sheep wool is prohibited under the animal waste regulations.

Out of the 278 blocked drains surveyed the most prevalent dam material used was peat turves, which accounted for 74% of dams. Plywood dams, plastic piles, Perspex, heather bales and combination block types accounted for between 3% and 7% each of the total number of dams surveyed (Table 3). The distribution of some of the

Fig. 1. Location of the drain-blocked field sites in the UK.

Table 1
Definition of block effectiveness classes.

Block class	Descriptor
1	Complete failure, blocked washed out
2	Partial failure
3	Mostly intact, not effective at higher flows
4	Intact but not redistributing water
5	Intact and redistributing water across the peat surface