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IMPACT OF BLANKET PEAT FOREST HARVESTINGON STREAM FLOW REGIME – A CASE STUDY IN THE BURRISHOLE CATCHMENT, CO. MAYO

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SUMMARY

The aim of this study was to investigate the impact of upland blanket peat forest harvesting on flow regimes in the Burrishoole Catchment. In this study, two before-after-control-impact (MBACI) experiments were carried out in three streams. Stream flows before and after clearfelling was continuously monitored. The results indicated that forest harvesting increased water yields and base flows but had very limited impact on flood risk downstream.

INTRODUCTION

Previous studies have indicated that forest harvesting would impact stream flow regime of the catchment. Bosche and Hewlett (1982) reviewed 94 experimental catchments and concluded that stream flow response to harvesting depends on the climate, especially the precipitation. Bruijnzeel (1988) indicated that whether the stream base flow increase or decrease after harvesting depends on the surface infiltration and evapotranspiration of the catchment. In temperate zones, base flow increase after harvesting was almost uniformly observed (Hornbeck et al. 1993, Brown et al. 2005). While increase in the intensity of peak flow and decrease in the time of concentration of flow after deforestation was reported (Hubbart and Matlock 2009), the forest harvesting impacts on floods may be small when soil conditions were maintained (DeWalle 2003, Robinson and Dupeyrat 2005). In Britain, Robinson and Dupeyrat (2005) carried out the first comprehensive study on the impact of harvesting on stream flow regimes in the Plynlimon research catchments in Wales and found that (i) the cutting of the forest increased total annual flows and augmented low flows and (ii) there was lack of impact of harvesting on storm peak. However, very few studies were conducted in upland blanket peat sites with temperate wet conditions. With shallow water tables and a low hydraulic conductivity at depth, blanket peatlands tend to generate rapid runoff and have shorter lag times and higher peat flows in response to rainfall events (Grayson et al. 2010, Rosa and Larocque 2008, Evans et al. 1999). Due to differences in tree species, soil types, forest management, catchment characteristics and climate, it is unclear how harvesting the upland blanket peat forests affect the stream flows in Ireland. Therefore, the objectives of this paper were to assess the impact of harvesting on water yield and flow regimes in the upland blanket peat in the west of Ireland.

MATERIAL AND METHODS

Site description

The Burrishoole catchment, located in County Mayo, Ireland, in the west of Ireland, consists of important salmonid productive rivers and lakes (Figure 1). About 18% of the catchment is covered by forests that were planted in the 1970s and which are now being, or are about to be, harvested. The study was carried out in two areas – Sraveragh and Glennamong, which are sub-catchments of the Burrishoole catchment. The distance between the two sub-catchments is about 5 km. The Sraveragh study site is drained by a small first order stream (Figure 1), was planted with Lodgepole Pine (*Pinus contorta*) between January and April 1971. The stream is equipped with two flow monitoring stations at stable channel sections, one upstream (US) and the other downstream (DS) of the experimental area (Figure 1b). Bole-only harvesting was conducted in area B and C from July 25th to September 22nd 2005.
In Glennamong two 10 ha sites which were planted with Lodgepole Pines (*Pinus contorta*) in 1975 and are drained by semi-natural drainages are chosen for the study. Two monitoring stations were established at the sites out flow (Figure 1). The area is covered by peat with the depth of about 0.5 - 1 meter. Bole-only harvesting was conducted in the study site from February 2011 to April 2011.

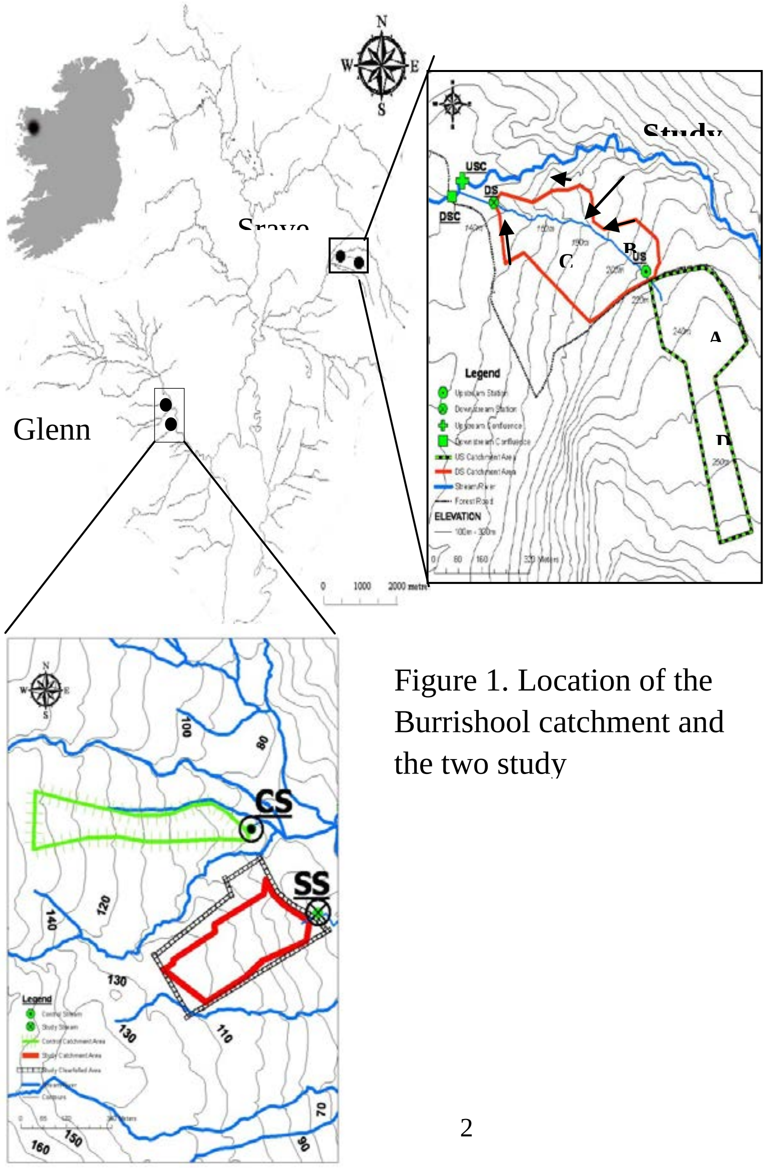

Figure 1. Location of the Burrishool catchment and the two study

Sampling, measurement and analysis

From April 2004 - March 2005, continuous water levels in the study stream were recorded at both the upstream station (US) and downstream station (DS) in Sraveragh, and converted to flows by a rating equation based on dilution gauging and current meter measurements. In April 2005, H-flume flow gauges were installed at the sites for flow measurement. In June 2009, H-flume flow gauges were also installed at the control and study sites in Glennamong.

RESULTS AND DISCUSSION

Monthly water yield

Figures 2 shows the monthly water yields from the study area (DS-US) and the control site (US) before and after harvesting in Sraveragh. The estimated and observed water yields at DS-US after harvesting were compared using a paired samples t-test at the 95% significance level (P =0.05) (http://www.spss.com), which indicated that the observed water yields increase was not statistically significantly higher than the 'predicted' water yields ($p<0.05$). Robinson and Dupeyrat (2005) studied the impact of commercial timber harvesting on stream flow regimes in four nested catchments in mid-Wales and detected increase of total annual flows. Johnson (1998) observed 25% to 30% increase in water yield when 100% forest was harvested in the precipitation rang 800 - 2400 mm per year. In another study, Hornbeck et al. (1970) found that annual flow could increased by 40% in the year following a 100% forest clearance. The water yield increase in the harvested area was attributed to reduced canopy interception and virtual elimination of transpiration (Johnson 1998). The impact of harvesting on water yield changes depends on the reduction of forest cover in the catchment basin. A reduction in forest cover of 20% was necessary before any changes were observed (Hornbeck et al. 1993). In their study, Robinson and Dupeyrat (2005) found that the smallest catchment with the largest proportion of area felled had the greatest flow increase. Figures 2b shows the monthly flows from the study and the control sites one year before harvesting and the first 6 months after harvesting in Glennamong. Significant monthly flow increase was also observed after harvesting (t-test, $p<0.1$), though the 6 months of after harvesting period was very short.

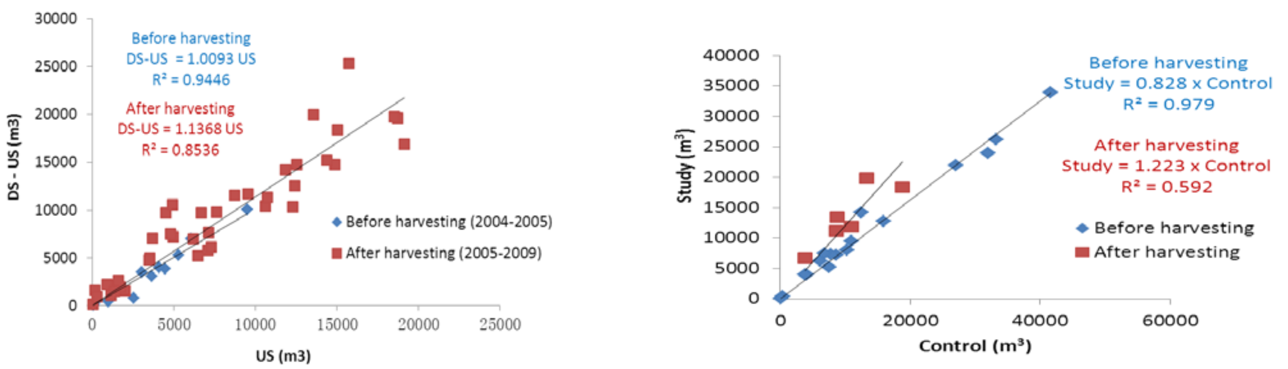

Figure 2.

Impact of harvesting on peak flows

Figure 3 shows the peak flows during the storm events at study and control sites before and after harvesting in Sraveragh and Glennamong, respectively. Slight peak flow increase was observed at both sub-catchments after harvesting. However, statistic analysis indicated that the increase was not significant. Figure 4 show the accumulative peak flows. They further confirmed that the impact of harvesting on the peak flow was small. In their studies across European, Robinson et al. (2003) found that the impact of forest harvesting on extreme flows was relatively small and difficult to detect in the North West European conifers. They complete clear felled one of their study sites - Glenturk which is close to our study sites, and only observed moderate peak flows increase. They attributed the lack of peak flow response to (1) minimum soil disturbance and (2) the presence of harvesting residues on the felled area (Robinson et al., 2003). Peak flow increases are usually due to the reduced infiltration which can be caused by soil compaction and disturbance. DeWalle (2003) also noted that where forest felling significantly increased flood flows soil was generally suffered severe disturbance. In this study, good management practices such as proper use of brash mats and harvesting only in dry weather were implemented, and soil surface disturbance were minimized (Rodgers et al., 2010).

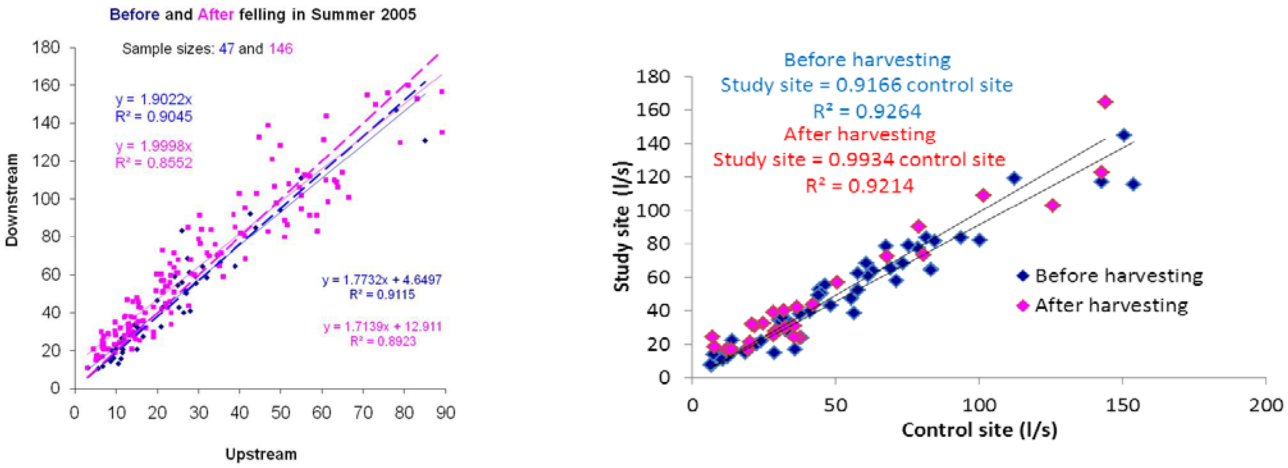

Figure 3

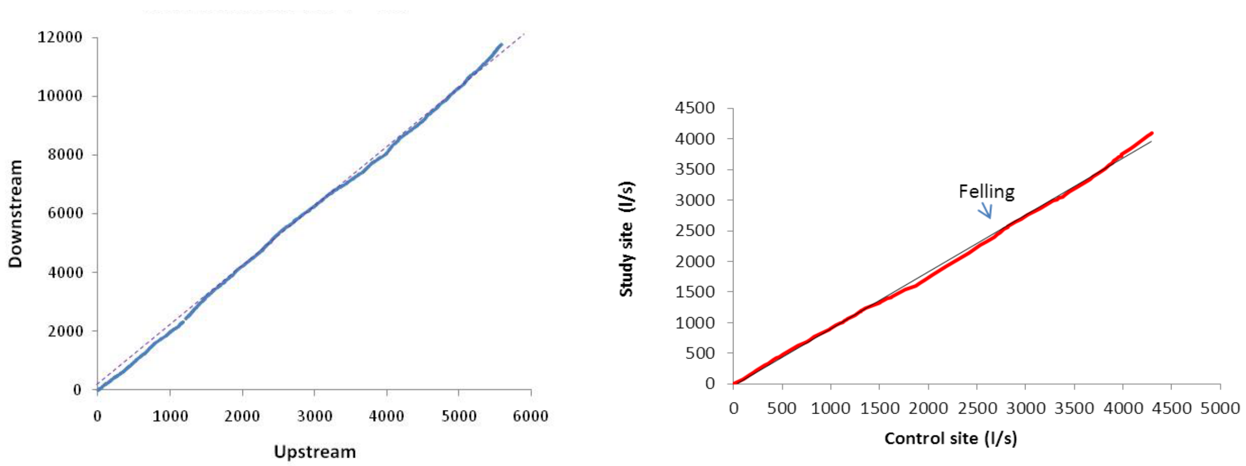

Figure 4

Impact on low flows

The 95-percentile flow is used to determine the base flow at the control sites in the two sub-catchments. Figures 5a and 5b show the chronological accumulated flows at control and study sites during the base flow periods before and after harvesting in Sraveragh and Glennamong, respectively. In both sub-catchments, harvesting significantly increased the base flows. The increase in base flow after harvesting could be due to the less evaporation (Robinson et al., 2003). Robinson et al. (2003) also observed baseflows increase in three of their experimental catchments.

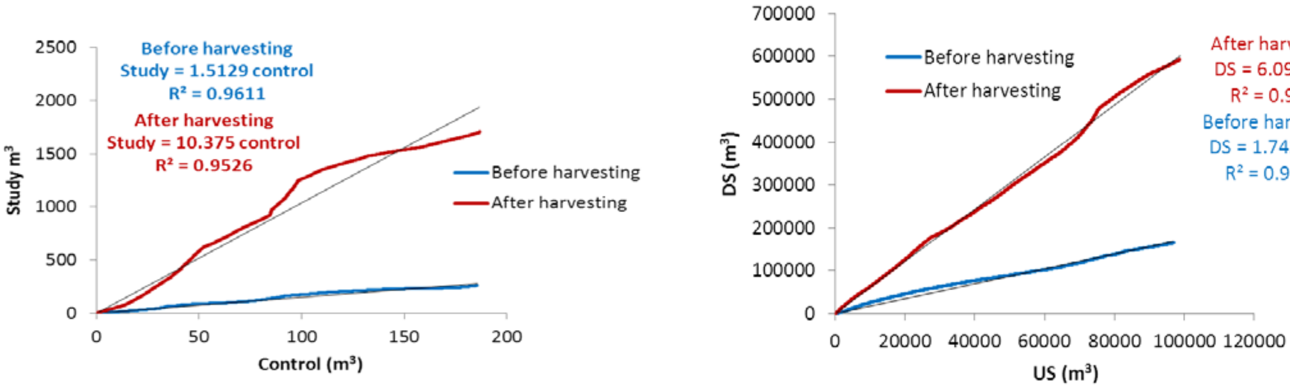

Figure 5

CONCLUSION

Two paired catchment studies were carried out in the Burrishoole Catchment in the west of Ireland to investigate the impact of upland blanket peat forest harvesting on stream flow regimes. Monthly water yield, peak flow and base flow were used as the impact indicators. The results indicated that while forest harvesting increased the monthly water yield and base flow significantly, it had very little impact on the peak flows. This could be due to the implementation of the good management practices such as proper use of brash mats and harvesting only in dry weather minimized soil surface disturbance.

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