Effects of Land Management on Flood Risk

OJ Francis[1], Z Frogbrook[2], BM Jackson[1], M Marshall[1], NR Mcintyre[1], B Reynolds[2], I Solloway[1,2], HS Wheater[1]

[1] Department of Civil and Environmental Engineering, Imperial College London, London SW7 2AZ, UK
[2] Centre for Ecology and Hydrology, Bangor, Gwynedd LL57 2UP, UK

Introduction

Effects of changing land management on flooding are being studied in the Nant Pontbren, a headwater tributary of the River Severn in Mid-Wales. To identify local effects of land management and to develop a methodology to represent catchment-scale effects, a multi-scale experimental and modelling programme is underway at Pontbren. This work forms part of the Flood Risk Management Research Consortium (FRMRC) and builds on an initiative of the "Pontbren group"; a consortium of ten hill farming families aiming to provide a more sustainable approach to farming. Issues addressed in current work include effects of grazing and the establishment of tree shelter belts.

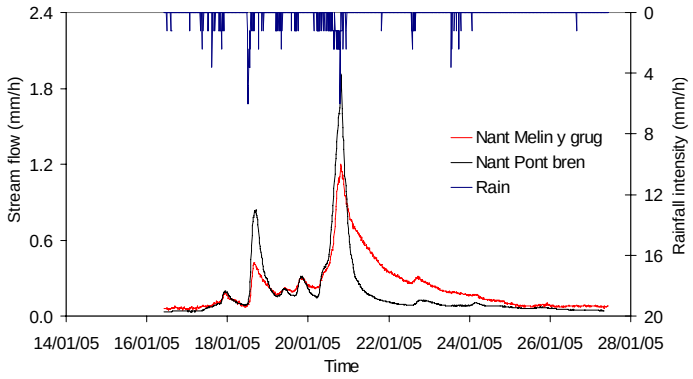

Fig. 1: Stream flow and rainfall intensity measured at Pontbren

Experimental results

The experiments include land use manipulation plots, hillslope scale studies and multi-scale streamflow measurements. Dominant runoff response of the clay soils occurs as overland flow and drainflow; preliminary data suggest an improvement in soil structure and permeability under trees. A change in the balance of runoff processes occurred as a result of antecedent soil moisture conditions caused by the relatively hot dry summer in 2006 (Table. 1).

Significant differences in stream flow have been observed (Fig. 1), between the Nant Pontbren (black line) which drains an area of largely improved grassland (2% unimproved 4% semi improved 79% improved) and Nant Melin y grug (red line) which drains a less improved area (52% unimproved 13% semi improved 13% improved).

Storm Event	Rainfall	Total Runoff	Overland flow	Drain flow	Total Runoff
	mm	mm	% of rainfall	% of rainfall	% of rainfall
30/11/2005 – 11/12/2005	51.4	31.8	16.4	40.1	56.5
08/11/2006 – 26/12/2006	384	176.5	2.2	43.8	46.0

Table 1: Overland and field drain flow at instrumented hillslope during winter storm events in 2005 and 2006

Model development

Local scale impacts of upland land use management practices are being evaluated through analysis and interpretation of the experimental data at Pontbren. Both data and detailed modelling studies suggest that soil and root differences in shelter belts dampen runoff response. Furthermore, results from simulations conditioned on experimental data suggest that targeted small scale changes, such as carefully located shelter belts, can significantly influence runoff at the local scale (Fig 2). Meta modelling is used to capture the main aspects of hillslope response under different land management practices and embed these within a catchment model, allowing the impact of changing practices to be considered. Fig. 3 presents example scenarios. Although further monitoring is required to better understand the hydrological responses under change, results are promising. Additional years with contrasting conditions will further inform understanding and refine predictions.

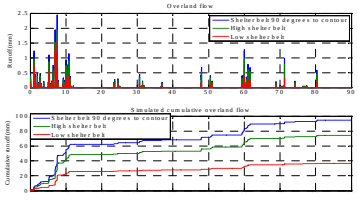

Fig 2: Hillslope response when changing locations of 12% tree cover within grassland

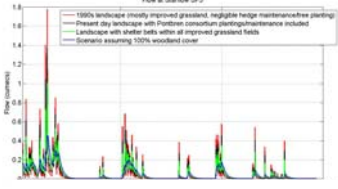

Fig 3: Predictions under different land management scenarios

Find out more…

Marshall et al. (2006) The impact of upland land management on flooding; preliminary results from a multi-scale experimental programme. Proc. BHS National Symposium, Durham

Jackson et al. (2006) The impact of upland land management on flooding; preliminary results from a multi-scale modelling programme Proc. BHS National Symposium, Durham

Contact: Howard Wheater h.wheater@imperial.ac.uk