

Case study 29. Investigating the interaction between semi-natural floodplain woodland and flood flows at Great Triley Wood

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Main driver: Flood risk management

Project stage: Medium to long term research study



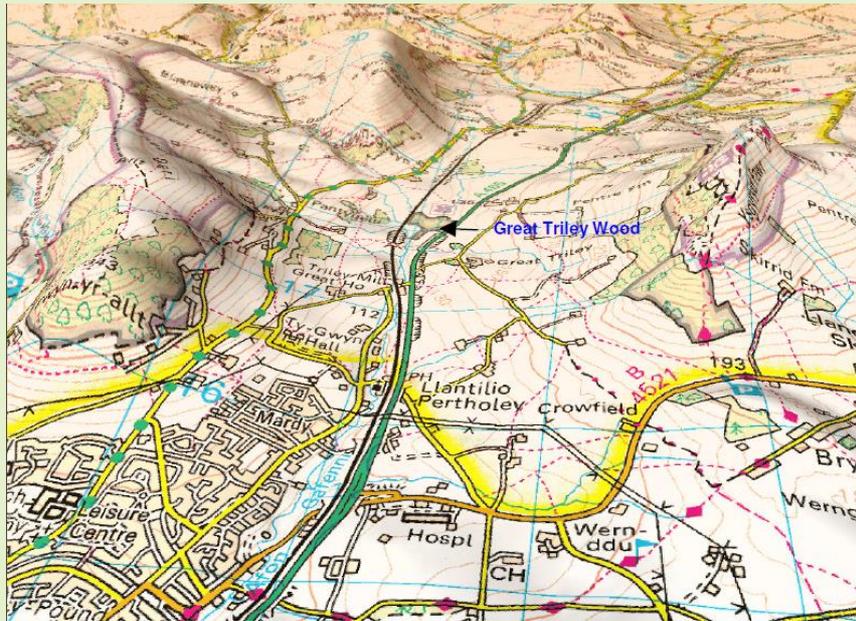
Photo 1: Large woody dam in Great Triley Wood (source: Forest Research)

Project summary:

The project was established as a research study to investigate how floodplain woodland affects flood flows. Great Triley Wood is a semi-natural, floodplain woodland owned and managed by the Woodland Trust. The site provided an opportunity to measure how trees, undergrowth and woody debris affect the hydraulic roughness of the floodplain and therefore the storage and passage of flood flows. Results are used to provide 'hard' evidence of how floodplain woodland impacts on flood risk and to help develop and test hydraulic models for wider application.

Key facts:

Floodplain woodland dissipates flood energy, reducing flood velocity and increasing local water depths. This can reduce downstream flood peaks but increase upstream flooding due to the backing up of floodwaters. The formation of large woody dams has an important role to play in storing and deflecting flood flows. Individual dams can delay a 1% annual exceedance probability (AEP) event by 2–3 minutes.



Map 1: 3D image of the Afon Gafenni catchment on a 1:50,000 OS backdrop

1. Contact details

Contact details

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2. Location and catchment description

Catchment summary

National Grid Reference:	SO 311181
Town, County, Country:	Abergavenny, Gwent, Wales
Regional Flood and Coastal Committee (RFCC) region:	Wales
Catchment name(s) and size (km²):	Afon Gafenni, 22km ²
River name(s) and typology:	Afon Gafenni; low, small and calcareous
Water Framework Directive water body reference:	GB109056032990
Land use, soil type, geology, mean annual rainfall:	Predominantly improved grassland on brown earth soils derived from sandstone Mean annual rainfall: 1,085mm (1981 to 1990)

3. Background summary of the catchment

Socioeconomic/historic context

This is a site-based research project and not specifically designed to provide flood protection. Great Triley Wood is a 6ha, mainly mature, semi-natural, floodplain woodland near Abergavenny in south Wales (Map 1). It has been subject to varying levels of management over its history, with low intensity thinning practised since the Woodland Trust took ownership. The main river and a number of smaller tributaries are unconfined as they flow through the wood and migrate across the wooded floodplain. Woodland cover occupies 13% (302ha) of the catchment, the majority of which comprises native broadleaved woodland. There are a total of 10ha of floodplain woodland in the catchment.

Flood risk problem(s)

Abergavenny is mainly affected by fluvial flooding from the main channel of the River Usk. The Afon Gafenni flows through the Llantilio Pertholey community where 32 properties are at risk of fluvial flooding from a 0.1% AEP event. The small size of Great Triley Wood and the limited extent of wider woodland in the catchment mean that woodland cover is unlikely to be affecting current flood risk.

Other environmental problems

The water body is at 'moderate ecological status' due to failures for fish and phosphate levels.

4. Defining the problem(s) and developing the solution

What evidence is there to define the flood risk problem(s) and solution(s)

The project is not designed to address a specific flood risk problem. It is a site-based research study exploring the physical interaction between floodplain woodland and local flood flows. The data captured will inform understanding of how woodland creation and management could be used to reduce flood risk for affected communities. Quantitative evidence will improve confidence in the use of woodland measures and assist with model development and testing for wider application.

What was the design rationale?

The project has 4 objectives:

- to quantify the hydraulic effects of an existing floodplain woodland during flood flow conditions
- to evaluate the contribution of woodland to the hydraulic roughness of the floodplain
- to artificially construct a series of large woody dams and investigate the hydraulic effect across a full range of flow conditions
- to model the hydraulic effect of the floodplain woodland and large woody dams using 1D and 2D hydraulic models and use the data collected in the field for validation and calibration purposes

At the core of the project is the collection of water level and survey data to measure how the floodplain woodland affects flood flows. Initially, a total of 4 water level recorders were installed along the main stream and on a principal tributary to measure stream water level at 15-minute intervals. Measurements began in 2005 and are ongoing. Cross-section surveys of the river and floodplain, plus assessments of hydraulic roughness, inform model development and testing.

Nine large woody dams were installed along the main watercourse and a principal tributary in 2007 to examine the impact on flood flows. These were designed to reflect natural large woody dams and involved the felling of 2–4 bankside trees to create an open framework of logs across the stream. Logs were wedged or placed against bankside stumps of trees, but not secured into place using wire or posts. The plan was to study the dynamics of natural dams, recording how these evolved through the capture and loss of in-stream woody debris over time. Regular surveys are made to measure changes

to the structure of the each dam and how these affect water flows and sediment deposition. Occasional electrofishing surveys have been undertaken by the Environment Agency/Natural Resources Wales to examine how the large woody dams affect fish populations.

Project summary	
Area of catchment (km²) or length of river benefitting from the project:	This site-based project is focused on Great Triley Wood, which occupies 6ha of the 22.9km ² catchment and straddles 700m of the Afon Gafenni.
Types of measures/interventions used (Working with Natural Processes and traditional):	Mainly mature, semi-natural, native floodplain woodland plus large woody dams
Numbers of measures/interventions used (Working with Natural Processes and traditional):	9 large woody dams installed along the main river and principal tributary
Standard of protection for project as a whole:	Not applicable – this is a site-based research project and not specifically designed to provide flood protection
Estimated number of properties protected:	Not applicable

How effective has the project been?

The project has demonstrated that floodplain woodland can exert a significant impact on flood flows. In particular, the formation of large woody dams promotes out-of-bank flows during flood events, diverting flows across the floodplain, where they further interact with standing trees, shrubs and large woody debris on the woodland floor. Spreading flows creates multiple side channels, further attenuating floodplain flows. Observed data were used to inform modelling, with predictions that individual dams could increase local flood levels by up to 1.46m, which created a backwater effect that extended a distance of 165m upstream. There was a maximum reduction of 2.1ms⁻¹ in water velocity at peak flow, while the 5 dams in the main watercourse delayed the travel time of the flood peak for a 1% AEP event by as much as 15 minutes. This compared with a delay of 10 minutes for the 4 dams over a 0.3km reach in the tributary stream.

The large woody dams appeared to be providing good habitat for trout, particularly the parr age group. It has not been possible to establish changes in fish numbers due to the dams diverting channel flows. Natural large woody dams are dynamic features, shifting during high flows, with washed out material often being caught by the next downstream dam. They can act as very effective sediment traps, but this reduces in-stream flood storage capacity and can present a barrier to fish movement.

5. Project construction

How were individual measures constructed?

The large woody dams were constructed by felling a number of bankside and nearby trees across watercourses. Felled logs were hand winched or moved manually into place to create an overlapping framework of logs. Bankside stumps, forked trees and other features were used to provide bracing, with logs slotted into place upstream of these.

How long were measures designed to last?

The large woody dams were designed as self-sustaining features, building with the in-wash and capture of woody debris from upstream woodland and balanced by losses due to wash-out during high flow events. The dams continually evolve and occasionally shift, with washed z-out material often being

caught by the next downstream dam. They therefore perform best as part of a network of dams, located within floodplain woodland or along reaches lined by riparian woodland.

Were there any landowner or legal requirements which needed consideration?

Landowner approval was required to build the dams and to fell bankside trees to form these. By raising water levels during flood flows, the dams act to increase ground wetting and overbank flows, which can impact on woodland management. There is also a backing up of flood flows, which can increase the risk of flooding local assets. None of these issues arose at Great Triley Wood since the woodland is managed as a semi-natural habitat and no assets are at risk.

Consent was required from the Environment Agency for the original construction of the dams.

6. Funding

Funding summary for Working with Natural Processes (WWNP)/Natural Flood Management (NFM) measures

Year project was undertaken/completed:	The project began in 2005 and is ongoing The network of 9 large woody dams was installed in 2007.
How was the project funded:	The project has primarily been funded by the Forestry Commission at a level of ~£10,000 per year. Additional funding (£27,000) was received from the EU in 2006 to 2008 as part of the Robinwood Interreg IIIC project.
Total cash cost of project (£):	~£160,000 to date
Overall cost and cost breakdown for WWNP/NFM measures (£):	The installation of the large woody dams was not costed as this used in-house labour and standing trees, and was part of a trial approach using an open framework of logs to try and replicate natural processes of dam formation. Costs involved were mainly for running the project, particularly for staff time for set-up, monitoring, data analysis and reporting. There were also costs involved in the purchase of water level recorders and installing the large woody dams.
WWNP/NFM costs as a % of overall project costs:	All costs were for research and monitoring of the interactions between floodplain woodland and flood flows and thus for WWNP/NFM.
Unit breakdown of costs for WWNP/NFM measures:	Not applicable or available
Cost–benefit ratio (and timescale in years over which it has been estimated)	Not applicable – site-based research project

7. Wider benefits

What wider benefits has the project achieved?

The project has shown that the presence of large woody dams benefits water quality by trapping sediment within channels and on the floodplain. Over 1.5m³ of sediment was deposited behind a single dam. This also helps to remove the nutrients that are typically attached or absorbed to sediment, such as phosphate. Fish monitoring suggested that the dams improved habitat conditions for brown trout,

especially trout parr. The action of the dams in promoting out-of-bank flows enhanced the quality of the floodplain woodland habitat.

How much habitat has been created, improved or restored?

The installation of 9 large woody dams is expected to have improved the quality of the 6ha floodplain woodland habitat by promoting out-of-bank flows, rewetting the floodplain and through sediment deposition.

8. Maintenance, monitoring and adaptive management

Are maintenance activities planned?

The water level recorders and related monitoring equipment will continue to be maintained for data capture. The Woodland Trust will continue to manage the woodland as a semi-natural, floodplain woodland habitat. No maintenance is planned for the large woody dams as these are being assessed as natural features.

Is the project being monitored?

Yes, this is primarily a research and monitoring project. The number of water level recorders has varied over time and there are now 2 devices located upstream and downstream of the large woody dam reach on a tributary of the Afon Gafenni, which are capturing data at 15-minute intervals. This monitoring is supplemented by regular surveys of the condition of the large woody dams.

Has adaptive management been needed?

Not to date but flow diversions caused by large woody dams could necessitate changes to the network of water level recorders to capture bypass flows.

9. Lessons learnt

What was learnt and how could it be applied elsewhere?

Natural large woody dams are dynamic features that are subject to gains and losses of woody material during high flow events. The stability of individual dams depends on channel and bankside factors, but larger material is generally retained in the system where a network of dams is in place. Dams are vulnerable to silting up when their porosity is reduced by finer woody material and there is high sediment delivery from upstream. While this can benefit water quality and enhance out-of-bank flows, it reduces in-stream flood storage and can form a barrier to fish. The action of large woody dams in spreading flows across the floodplain and enhancing the formation of side channels adds to the difficulty of quantifying changes to flood flows through water level measurements.

10. Bibliography

THOMAS, H. AND NISBET, T.R., 2007. *The Robinwood Robinlood report: evaluation of the impact of large woody debris in watercourses on flood flows*. Final Report to FC(W) on Robinwood Project. Available from: http://www.robin-wood.eu/uploads/robinwood_flood.pdf [Accessed 24 March 2017].

THOMAS, H. AND NISBET, T.R., 2012. Modelling the hydraulic impact of reintroducing large woody debris into watercourses. *Journal of Flood Risk Management*, 5 (2), 164-174.

Project background

This case study relates to project SC150005 'Working with Natural Flood Management: Evidence Directory'. It was commissioned by Defra and the Environment Agency's [Joint Flood and Coastal Erosion Risk Management Research and Development Programme](#).