Case study 28. Investigating the impact of floodplain woodland on flood flows in the River Cary catchment, Somerset

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Main driver: Flood risk management

Project stage: Modelling study

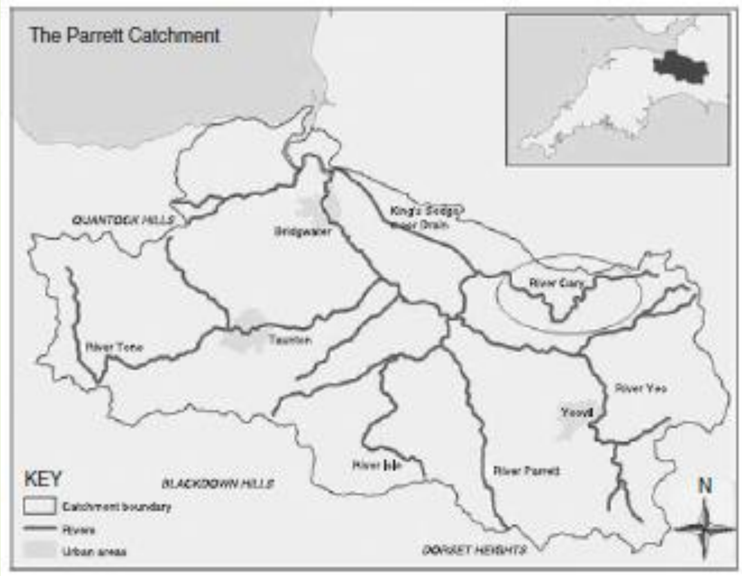
Photo 1: River Cary catchment **(source: Forest Research)**

Project summary:

The project was established as a modelling study to investigate how the planting of floodplain woodland can affect flood flows. The River Cary is a major tributary of the River Parrett in Somerset (Map 1) with extensive areas suitable for floodplain woodland restoration. A 2.2km long reach was selected to simulate the impact of different woodland planting scenarios on a 1% annual exceedance probability (AEP) event. Hydraulic roughness parameters were changed in one and two-dimensional hydraulic models to represent a shift from grassland to floodplain woodland. The results suggest that there is considerable scope for using strategically placed floodplain woodland to alleviate downstream flooding.

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 floodwater. The planting of 133ha of floodplain woodland along a 2.2km reach of the River Cary was predicted to increase local flood storage by 71% and delay the flood peak travel time by 140 minutes.



Map 1: Location of River Cary catchment and study site in south-west England

1. Contact details

Contact details	
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2. Location and catchment description

Catchment summary	
National Grid Reference:	ST 498291
Town, County, Country:	Somerton, Somerset, south-west England, UK
Regional Flood and Coastal Committee (RFCC) region:	Wessex
Catchment name(s) and size (km^2):	River Cary, 88.5km^2
River name(s) and typology:	River Cary; low, small and calcareous
Water Framework Directive water body reference:	GB108052015140
Land use, soil type, geology, mean annual rainfall:	Predominantly arable and improved grassland on calcareous pelosols (clay-rich topsoil over calcareous subsoil) and brown rendzinas derived from mudstone Mean annual rainfall: 737mm (1981 to 1990)

3. Background summary of the catchment

Socioeconomic/historic context

This is a site-based, explorative modelling study and not specifically designed to provide flood protection. It was part of a much larger study, the Parrett Catchment Project, which was tasked with formulating a strategy and integrated catchment plan for improving flood management for affected communities within the River Parrett catchment. The objective of this study was to explore how the restoration of floodplain woodland along a section of the River Cary catchment (Photo 1) could help to alleviate downstream flooding.

Flood risk problem(s)

Around 3,300 properties are at risk from flooding for a 1% AEP event in the River Parrett catchment, most of which lie within the towns of Taunton and Bridgwater. Fluvial flooding also affects a number of isolated communities throughout the catchment. Flooding is thought to be exacerbated by some farming practices increasing field run-off. Woodland creation and in particular the restoration of floodplain woodland was examined as a way of slowing down and holding back run-off to help reduce downstream flood risk.

Other environmental problems

The water body is at moderate ecological status due to failures for phosphate, macrophytes and phytobenthos.

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 was not designed to provide a specific level of flood protection for affected communities. It was a discrete, simulation study to examine the impact of restoring a sizeable area of floodplain woodland on local flood flows. The selected location was identified by 'opportunity mapping' as potentially suitable for planting floodplain woodland. Floodplain woodland is known to dissipate flood energy, reducing flood velocity and increasing local water depths. This can lower downstream flood peaks but increase upstream flooding due to the backing up of floodwaters.

What was the design rationale?

The project was designed to help quantify how the hydraulic roughness exerted by floodplain woodland could affect local flood flows. Standard 1D (HEC-RAS) and 2D (River2D) hydraulic models were used to simulate the effect of changing the vegetation cover on the floodplain from managed grassland/pasture to floodplain woodland. This change in vegetation structure was represented in the models by altering the parameters that control surface roughness to reflect the associated energy loss due to friction. Published values were selected for pasture with high grass and/or cultivated areas with row crops, and for a cover of dense, broadleaved woodland.

The models were set up for a 2.2km reach of the River Cary upstream of Somerton in Somerset. Flow data were obtained from the local Environment Agency gauging station at Somerton and topographic data using the Environment Agency's 2m resolution LiDAR (light detection and ranging) coverage, plus 10 surveyed cross-sections of the river channel. The maximum width of the floodplain reached ~400m and the total area extended to 133ha. Three model simulations were compared for a 1% AEP event:

- a baseline scenario of the floodplain covered by pasture
- a complete cover of dense broadleaved woodland
- a 50ha block of dense broadleaved woodland positioned along a 500m section in a 2.2km reach

Project summary	
Area of catchment (km^2) or length of river benefitting from the project:	This was a simulation study, which modelled the impact of restoring floodplain woodland along a 2.2km length of the River Cary. The total area of floodplain involved was 133ha, which is around 1.5% of the total upstream catchment area of 88.5km^2.
Types of measures/interventions used (Working with Natural Processes and traditional):	Simulated planting of 133ha of native floodplain woodland
Numbers of measures/interventions used (Working with Natural Processes and traditional):	As above
Standard of protection for project as a whole:	Simulation assessed the impact of planting on the 1% AEP flow
Estimated number of properties protected:	Not determined; simulation limited to modelled reach. However, the predicted delay in the downstream progression of the flood peak would extend flood warnings and could desynchronise subcatchment flood peaks, potentially reducing flood risk and damages downstream.

How effective has the project been?

The project was very effective in demonstrating through the use of standard hydraulic models how floodplain woodland can exert a significant impact on flood flows. In particular, the greater barrier presented by the physical presence of trees, undergrowth and deadwood on the floodplain and within water channels greatly increases energy loss by friction, delaying and holding back flood flows.

A complete cover (133ha) of floodplain woodland along a 2.2km reach of the River Cary was predicted to increase local flood water storage by 71% and delay the flood peak by 140 minutes. A smaller 50ha central block of woodland that spanned the full width of the floodplain had less of an effect, but was still significant in storing 15% more flood water and delaying the flood peak travel time by 30 minutes. Notably, there was also a backwater effect that extended for a distance of 300–400m upstream for the complete woodland cover scenario, potentially increasing the risk of flooding for any local assets. It is concluded that there is considerable scope for using floodplain woodland to reduce downstream flood risk.

5. Project construction

How were individual measures constructed?

Not applicable – this was a simulation study modelling the impact of planting floodplain woodland.

How long were measures designed to last?

As above – the woodland scenarios represented a permanent change in land use from pasture to native floodplain woodland.

Were there any landowner or legal requirements which needed consideration?

These issues did not arise as this was a simulation study.

Efforts to encourage landowners to plant small areas (~5ha) of floodplain woodland in the wider River Parrett catchment have proved successful, but it remains a struggle to obtain agreement to plant larger areas, both here and in the wider country. The main barrier has usually been the lack of sufficient incentive/payment to cover the expected losses in capital value of the land and agricultural income, as well as to compensate for the perceived risks associated with land use change. Floodplain land is generally highly valued for agriculture and thus more difficult to secure for woodland planting, especially for 'unproductive' native woodland. Restrictions apply to planting woodland along some watercourses, particularly those designated as a 'main river' for flood protection purposes, where periodic access is required for maintenance of embankments and river channels. Consent may be required from the water regulatory authority for planting trees within 7m of a main river.

6. Funding

Funding summary for Working with Natural Processes (WWNP)/Natural Flood Management (NFM) measures	
Year project was undertaken/completed :	The modelling study was undertaken in 2004.
How was the project funded:	The study was funded by the Forestry Commission and drew on data provided by the Environment Agency.
Total cash cost of project (£):	Not available – in-house modelling study
Overall cost and cost breakdown for WWNP/NFM measures (£):	Not applicable – purely a simulation study with no measures implemented on the ground
WWNP/NFM costs as a % of overall project costs:	Not applicable
Unit breakdown of costs for WWNP/NFM measures:	Not applicable
Cost–benefit ratio (and timescale in years over which it has been estimated):	Not applicable

7. Wider benefits

What wider benefits has the project achieved?

This was a hydraulic modelling study and did not attempt to assess the wider benefits of restoring floodplain woodland. Nevertheless, floodplain woodland could be expected to provide additional benefits for society and the environment, including improvements to water quality, fisheries, carbon sequestration, nature conservation, recreation and landscape.

How much habitat has been created, improved or restored?

None – this was a simulation study.

8. Maintenance, monitoring and adaptive management

Are maintenance activities planned?

Not applicable

Is the project being monitored?

Not applicable

Has adaptive management been needed?

Not applicable

9. Lessons learnt

What was learnt and how could it be applied elsewhere?

Careful consideration needs to be given to the siting of new/restored floodplain woodland. A detailed analysis of the flood hydrograph and how flows accumulate within larger catchments helps to identify the best opportunities for intervening to desynchronise subcatchment contributions and attenuate the main flood peak. There is also scope to increase the effectiveness of floodplain woodland to delay flows by enhancing flow resistance through woodland design and management factors, including the supply of deadwood and formation of large woody dams. Large woody dams have an important role to play in reducing water velocity within river channels and promoting out-of-bank flows, further dissipating flood energy through interactions with floodplain woodland.

10. Bibliography

ENVIRONMENT AGENCY, 1996. *The restoration of floodplain woodlands in lowland Britain: a scoping study and recommendations for research*. Report No. W15. Bristol: Environment Agency.

NISBET, T.R. AND BROADMEADOW, S.B., 2003. *Opportunity mapping for trees and floods. Final report to the Parrett Catchment Project Group.* Farnham, Surrey: Forest Research.

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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.