Case study 20. From Source to Sea: the Holnicote Experience

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Main driver: A multi-objective approach to flood risk management

Project stage: Post-construction monitoring

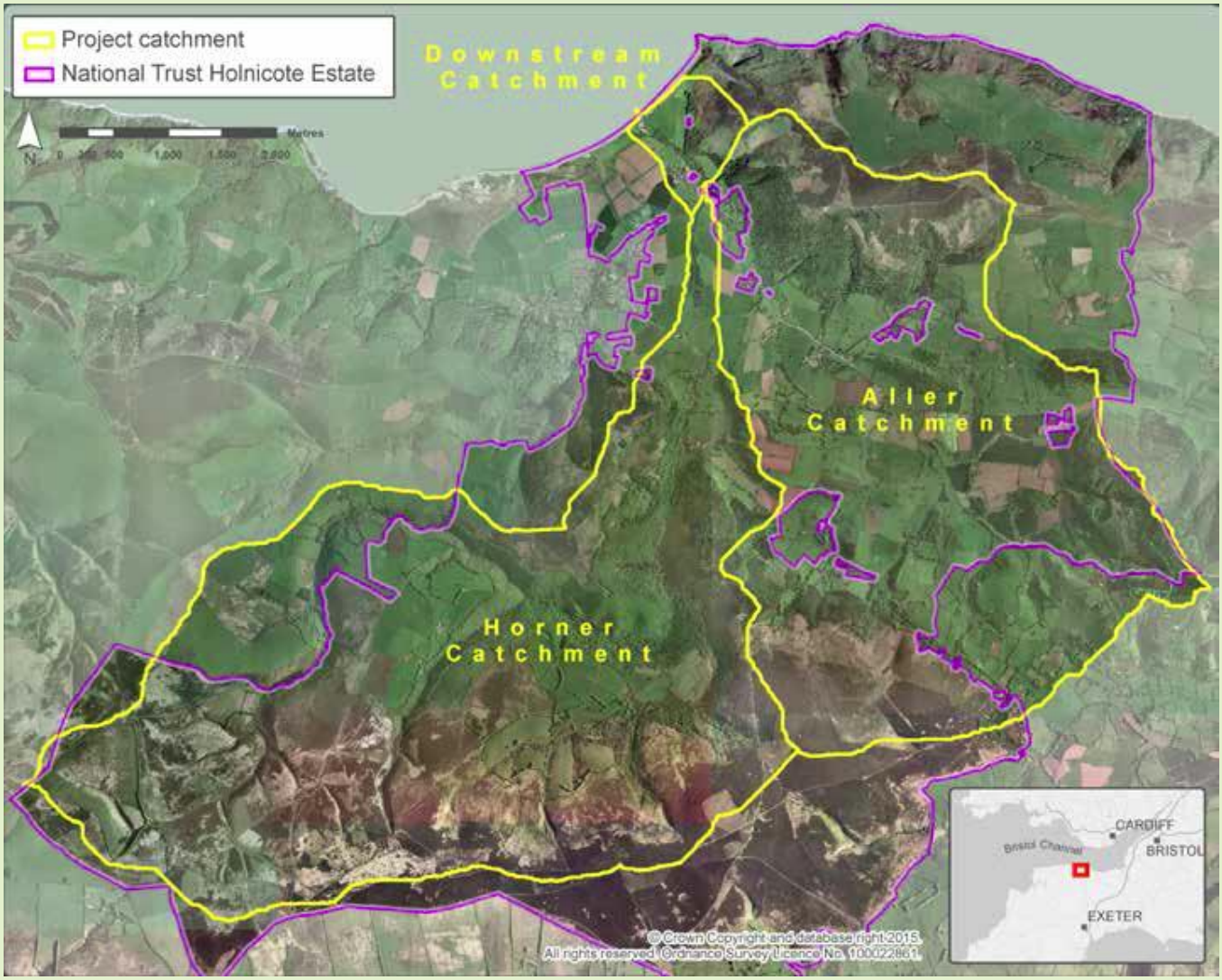
Photo 1: **The flood storage area at Holnicote in action (source: National Trust)**

Project summary:

The aim of the Holnicote project in Somerset (Map 1) is to provide evidence to demonstrate how Working with Natural Processes (WWNP), implementing a range of Natural Flood Measures (NFM) measures, at the catchment scale can contribute to a reduction in flood risk while producing a range of other environmental and social benefits. A hydrological monitoring network was installed in 2010 to provide high quality, high resolution rainfall, stage and flow data for assessing the impacts of the NFM measures. A range of NFM measures have been implemented since 2011 including upland drainage attenuation features, woody dams, woodland creation, leaky weirs and offline storage areas (Photo 1). Since the project began, there has been no flooding in the vulnerable downstream villages that have experienced regular flooding in the past, even during the extreme rainfall events of winter 2013 to 2014, where measured hydrological data clearly showed a significant reduction in flood peak. This was confirmed when the same data were run through 'before' and 'after' NFM implementation scenarios in the hydraulic flood model of the catchment.

Key facts:

During an extreme rainfall event on an already saturated catchment in late December 2013, NFM interventions reduced the flood peak by 10%. With a combined insurance value of £30 million, none of the 98 properties at risk were affected by flooding then, or during any subsequent flood events. Th3e capital costs of constructing the offline storage bunds on the floodplain upstream of the vulnerable properties were £163,000, a small cost compared with the insured value of the properties at risk of flooding.



Map 1: **Location of Holnicote Estate** (Source: National Trust)

1. Contact details

Contact details	
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2. Location and catchment description

Catchment summary	
National Grid Reference:	SS 920467
Town, County, Country:	Near Minehead, Somerset, UK
Regional Flood and Coastal Committee **(**RFCC) region:	Wessex
Catchment name(s) and size (km^2):	Horner Water (22km²) and River Aller (18km²)
River name(s) and typology:	Aller and Horner Water
Water Framework Directive water body reference:	GB108051020220 and GB108051020230
Land use, soil type, geology, mean annual rainfall:	Ranging from high moorland (500m above Ordnance Datum (AOD)), through ancient sessile oak woodland to grassland and arable farmland, historic villages to the sea. Soils range from peat in the uplands to deep loam, sandy soils and clay over Old Devonian (Hangman) sandstone principally. Annual rainfall is 1,400mm on Exmoor, the highest part of the Holnicote Estate, to 750mm in the lower catchment.

3. Background summary of the catchment

Socioeconomic/historic context

Water management has played a large part in shaping the historic landscape, ranging from drainage ditches on the upper moorland, irrigation gutters on upland farms, relict water meadows, at least 3 mills and associated leats. Functioning water meadows around the Aller ceased in the early 20th century and the river has increasingly become disconnected from the natural floodplain through changes in land management practices and watercourse maintenance activities. Later, construction of tarmac roads across the moorland and the widening and improvement of the main A39 through the floodplain in the 1970s is likely to have increased the speed and volume of surface water run-off reaching the main watercourses. The whole catchment lies within Exmoor National Park and the area is an attractive destination for visitors. Tourism provides key direct and indirect employment in the area through, for example, B&Bs, caravan and camp sites, tea rooms, pubs and riding stables.

Flood risk problem(s)

At the start of the project, the Environment Agency Flood Map indicated that nearly 100 properties were at high risk of flooding. There is an early warning siren system on both the Aller and Horner watercourses, triggered by rapid level changes at the Environment Agency gauging stations, which was upgraded recently. Properties are at risk from flooding from these watercourses, which have become constricted through road and bridge construction and through the lack of connected floodplain capacity. There is also evidence of increased run-off from a drainage network of roads, paths and tracks in the upper catchment and from inappropriate and/or untimely soil and land management activities on vulnerable farmland. The most recent rainfall event that caused serious flooding was in 2000, when a significant number of properties were flooded and the A39 road became impassable. Since the project started, a property level protection scheme has been put in place to improve resilience in the most vulnerable properties.

Other environmental problems

Most of the catchment is at good ecological status apart from the Horner Water which is at moderate due to low light levels from overshadowing in Horner Wood. The majority of the Horner catchment has protected status as a Site of Special Scientific Interest (SSSI), National Nature Reserve (NNR) and Special Area of Conservation (SAC). Water is a significant contributor to the high ecological value of the catchment both directly (mires, flushes and pools) or indirectly, for example, through creating temperate rainforest conditions in Horner Wood, resulting in more than 330 species of lichen.

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

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

This project was 1 of 3 commissioned by Defra in 2009 as a multi-objective flood management scheme to demonstrate how NFM measures implemented across a complete catchment could reduce flood risk (National Trust 2015). In addition to desk-based studies and catchment walkovers, a range of hydrologic and hydraulic modelling approaches were applied to different aspects of the project to explore the various NFM options. For the proposed Aller floodplain measures, a fully linked 1D-2D model was developed that could investigate the spread and depth of flood inundation under a range of scenarios, including design and real flood events and climate change predictions, both with and without the various design options in place. Refined as an animation, this model provided a valuable tool in public engagement by demonstrating the likely benefits from NFM implementation.

What was the design rationale?

Early on in the project it became apparent that, by working throughout a complete catchment, the scale of interventions and management changes would be critical to effective outcomes. Positive effects on flow and reduction of flood risk could only be achieved by designing and implementing a range of medium- to large-scale measures, including some well-targeted soft engineering schemes. These measures included:

- moorland headwater storm run-off impedance works
- in-channel woody dams and natural woody material retention
- woodland planting
- on-line leaky dams
- floodplain storage bunds
- reversion of arable fields to grassland
- *Molinia* (purple moor grass) management

Most of these measures used tried and tested designs and techniques, though the storage bunds were specifically designed to:

- minimise disruption to farming
- fit into an historic, much-visited landscape
- comply with all required consents/approvals/regulations
- only hold floodwater temporarily (this was critical due to the rapid response of the river to rainfall)

Project summary	
Area of catchment (km^2) or length of river benefitting from the project:	The whole of the Horner catchment ($22km^2$) and approximately $10km^2$ of the Aller catchment were directly affected.
Types of measures/interventions used (WWNP and traditional):	Upland run-off attenuation features, in-channel woody dams and leaky dams, changes of land use management and offline storage ponds and soakaways

Numbers of measures/interventions used (WWNP and traditional):	Drainage management along 19,250m of upland features, 41 natural woody dams, 5 storage bunds, 5 ha of new woodland, 5 fields of arable reversion, wet woodland pond restoration/excavation.
Standard of protection for project as a whole:	Initial results show a 10% reduction in flood peak during a >1 in 75 year event, but monitoring is continuing to enable full assessment of the results.
Estimated number of properties protected:	98 properties (55 National Trust and 43 private) – most of which are of historic importance and many are listed

How effective has the project been?

Using hydraulic modelling over a range of scenarios, the project was very effective in indicating the positive effects of catchment-scale NFM measures and the predicted reduction in flood peak was confirmed during the extreme weather conditions of winter 2013 to 2014. The flood storage bunds have sufficient capacity to contain significant volumes of additional water on the floodplain (for example, in excess of 20,000m^3 in a 100 year flood event). None of the 98 properties has flooded since completion of the construction in 2013 and, anecdotally, there is local opinion that the project has been successful in reducing the flood risk in the downstream villages.

5. Project construction

How were individual measures constructed?

Most of the construction work was carried out using contractors with extensive experience in hydrology/river restoration projects, with design input and advice from the consultant team of hydrologists and ecologists, National Trust staff, the Environment Agency, Exmoor National Park Authority and individual farm tenants.

How long were measures designed to last?

All measures have been designed to require little or no maintenance and have a long life expectancy. For example, the storage bunds will last relatively indefinitely but will require some top-up maintenance every 10–20 years. Due to the nature of the underlying geology and high visitor pressure, the upland interventions will require more regular maintenance work at 4–5 year intervals.

Were there any landowner or legal requirements which needed consideration?

As the site is owned by the National Trust and lies within Exmoor National Park, due consideration was always given to the effect of the measures on landscape, cultural history, biodiversity, natural resources and farm and cottage tenant requirements. Much of the land is protected through SSSI, NNR and SAC designations and thus required Natural England consents.

The upland area is also rich in archaeological sites, including many Scheduled Ancient Monuments, requiring advice consent from Exmoor National Park Authority Historic Landscape Officers.

The works also required flood risk consents from Environment Agency and, due to the potential storage volume of floodwater on the floodplain, under the Reservoirs Act the bund construction had to be approved as a low risk structure by a Defra Panel Engineer.

6. Funding

Funding summary for Working with Natural Processes (WWNP)/Natural Flood Management (NFM) measures	
Year project was undertaken/completed:	2009-2015
How was the project funded:	Core funded by Defra (£722,000) with additional funding from the Environment Agency and the National Trust.
Total cash cost of project (£):	Total cost of the demonstration project was ~£1.22 million, including significant in-kind contributions from both the Environment Agency and the National Trust.
Overall cost and cost breakdown for WWNP/NFM measures (£):	Overall costs for the NFM measures was approximately £280,000, £160,000 for the floodplain bunds and leaky weirs, £70,000 for upland works and £50,000 for woodland creation, woody dams work and arable reversion.
WWNP/NFM costs as a % of overall project costs:	~ 20%
Unit breakdown of costs for WWNP/NFM measures:	Not estimated
Cost–benefit ratio (and timescale in years over which it has been estimated):	Not known

7. Wider benefits

What wider benefits has the project achieved?

A Defra pilot research project was run in 2014 to 2015 to define and assess the key ecosystem services provided by the Holnicote NFM project and to investigate whether income could be derived to fund this work into the future through a Payment for Ecosystem Services (PES) scheme (Rogers et al. 2015). In addition to the direct flood risk benefits, the project has highlighted that there are significant soil erosion issues on the Holnicote Estate, particularly on the steeply sloping uplands of the Horner catchment and some of the ploughed fields in the upper Aller catchment. Land interventions carried out to improve soil management and reduce surface water run-off are likely to benefit water quality and agricultural productivity. Baseline work carried out by Exeter University has shown no significant water quality issues apart from high levels of suspended sediment following storm events. Further analysis is planned to assess the sediment loads following the NFM implementation.

How much habitat has been created, improved or restored?

Holnicote already has a rich biodiversity resource and the NFM project has increased the extent of habitats including wet woodland (by 7ha), deciduous woodland (5ha) and wet meadow (10ha. New habitats have been created including 12 scrapes on the floodplain and 150 catch pools on the uplands.

8. Maintenance, monitoring and adaptive management

Are maintenance activities planned?

All of the measures have been designed to minimise maintenance requirements and be mostly self-sustaining. However, the leaky weirs, floodplain bunds and the outflow pipe through them will require periodic checking, especially after floods, for continuing operational and structural integrity. The headwater

storm run-off impedance works will require repair work every 4–6 years due to ongoing visitor and livestock pressure.

Is the project being monitored?

A comprehensive hydrological monitoring and data telemetry network was designed and implemented in 2010 across the Horner and Aller catchments, including subcatchments, to capture any signals of change in the characteristics of the flood hydrograph that could be attributed to the upstream NFM measures. Dependent on funding, the hydrological monitoring will be continued in the medium term and research opportunities will be explored to further the understanding of the soil erosion and suspended sediment issues.

Has adaptive management been needed?

Due to erosion from high visitor pressure and relatively soft bedrock, the upland drainage interventions required upgrading to be more resilient and will require regular inspection and maintenance. To prevent the ground remaining waterlogged downstream of the storage bunds, some remedial drainage channels were created to return floodwater to the river after the main flood peak has passed.

9. Lessons learnt

What was learnt and how could it be applied elsewhere?

Soft-engineered, earthwork bunds on connected floodplains are a highly effective and environmentally sustainable method of preventing flooding by attenuating the peak stormflow. Other lessons learnt include:

- allowing natural woody dams to develop wherever possible within woodland areas
- the importance of early and regular engagement regarding consents/approvals, and with catchment stakeholders and local communities to gather local knowledge, discuss issues and report plans/progress
- regular dialogue with farmers to highlight the value of maintaining good agricultural practices that minimise the occurrence of soil compaction/degradation, rapid run-off and associated sediment transport issues

10. Bibliography

NATIONAL TRUST, ENVIRONMENT AGENCY PENNY ANDERSON ASSOCIATES AND JBA CONSULTING, 2015. *From source to sea: Natural Flood Management – the Holnicote Experience*. Swindon: National Trust.

ROGERS, S., POSE, S., SPENCE, J. AND HESTER, N., 2015. *Holnicote Payments for Ecosystem Services (PES) Pilot Research Project 2014-2015*. Final report to Defra on Project NR0156. Buxton, Derbyshire: Penny Andersen Associated Ltd.

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.