Sussex Flow Initiative

Author(s): Sandra Manning-Jones (SFI Project Officer), Gareth Williams (Environment Agency), Fran Southgate (Sussex Wildlife Trust).

Main driver: Flood mitigation; Water Framework Directive.

Project stage: In progress.

Project summary:

Sussex Flow Initiative (SFI) is an innovative partnership project between the Sussex Wildlife Trust, Environment Agency and Woodland Trust, based in the River Ouse catchment, East Sussex. SFI aims to promote and deliver Natural Flood Management (NFM) approaches helping to create a landscape that is more resilient to flooding, drought and climate change, and which delivers enhanced biodiversity and natural services. We have been working with local landowners, community groups, volunteers, the Adur and Ouse Catchment Partnership and many other stakeholders since 2012.

Following extreme flooding in the town of Uckfield, East Sussex in the year 2000, a student from the Durham University produced a model of the River Uck (a sub-catchment of the River Ouse), which indicated that the addition of NFM measures along specific river reaches could, in combination reduce flood peak in Uckfield by up to 12 cumecs. Subsequently in 2012 our pilot project, Trees on the River Uck (TrUck), was formed with the aim of establishing whether it was possible to deliver multiple (flood) benefits as well as Water Framework Directive objectives.

Through our work on TrUck it became clear that engagement with landowners and subsequent delivery would take time, particularly as Countryside Stewardship and Forestry grants were largely suspended / in transition during this period. It was clear that the original Durham University model outputs into action on the ground was a great deal more complex than the model showed. This forced us to develop our own flooding models linking detailed local information to national datasets and drivers (e.g. WFD)..

After five years, the SFI project has established sufficient momentum to start delivering NFM at a meaningful scale. The project has highlighted the multiple benefits which can be accrued from an NFM approach, and how these benefits can be targeted and applied across large landscapes. In 2014 we were ready to move beyond the Uck sub catchment and TrUck became the Sussex Flow Initiative, expanding our work to look at the fluvial reaches of the upper Ouse along with our original River Uck boundary. Since then we have been working closely with the Ouse & Adur Rivers Trust to create sub-catchment plans which highlight whole suites of measures which can be applied to improve landscape and environmental quality, as well as natural services and NFM.

The following NFM measures are the focus of our demonstration work (although not exclusively):

Natural woody flow deflectors and diverters; Washland meadows; Woodlands; Hedgerows; Shelter belts; Temporary natural water retention features; Land drainage modification; Seasonal and permanent open water features such as ponds and scrapes; Promoting positive soil stewardship and land management.

We also hope to increase floodplain woodland coverage in the upper headwaters of the River Ouse to 40% of the total floodplain (based on Environment Agency flood zone 2 extent) within the next 10 years (funding dependant).

Sussex Flow Initiative specifically aims to influence others to consider NFM approaches through:

- Demonstration. Promoting measures and providing evidence through local trail sites. Gradually adding small low risk measures. Assessing opportunities for larger future projects and interventions.
- Advocacy. Inspiring and influencing others to incorporate NFM approaches. For example: statutory bodies; lead local flood authorities; community groups; landowners; utilities operators.
- Signposting. Sharing our knowledge and experience. Producing evidence and guidance to help others implement NFM. Providing practical advice and support to others start other projects locally. Highlighting other resources and evidence available to support and facilitate work.

One of the key outcomes of the project has been to influence the flooding agenda both locally and nationally, to promote lowland NFM.We now have websites, a Facebook page, and a range of interpretative materials on NFM from blogs to booklets.

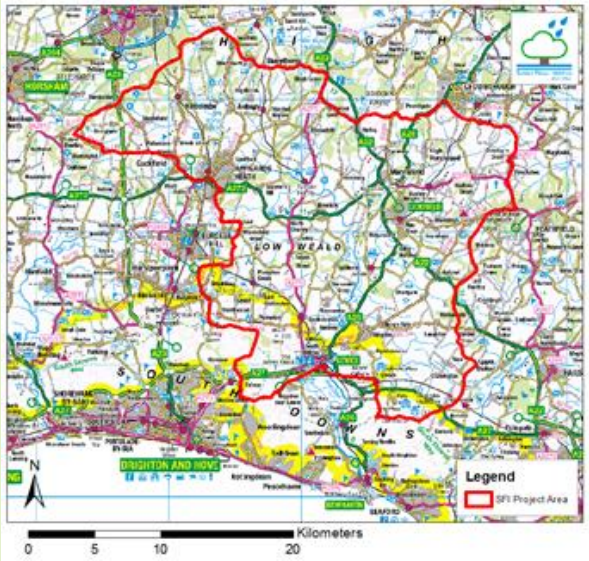
Our targeting of NFM has been directed through the assessment of opportunities linked to: Stakeholder and partner estates; priority Water Framework Directive waterbodies; FC/Countryside Stewardship target areas for water quality and flood risk management; small unprotected communities at risk of flooding; low risk sites highlighted by the SFI targeting models; sites identified by other local projects as being relevant or suited to NFM; ecosystem service provision.

We are currently interpreting an Ecosystem Services model for the whole catchment to use alongside NFM models.

Killer fact:

SFI (and previously Truck) has:

- created a range models and data to aid targeting and reduce risks including: Floodplain Woodland Habitat Potential model; Backwater Buffers (to buffer infrastructure from impoundment effects); Compound Topographic Wetness model; Woodland Water Storage assessment. We have assessed and incorporated other data and models produced by others including: River Habitat Survey data (OART); Habitat Potential Models (SWT); EcoServ-GIS, CaBA data.
- engaged and advised landowners covering 5,000ha of the Ouse (10% of the non-tidal catchment), including 70km of riparian land.
- completed detailed surveys of the river and riparian corridor for 50km of main river in partnership with the Ouse and Adur Rivers Trust.
- undertaken detailed assessment of two sub-catchment areas (50km2) providing maps of potential and priority NFM measures, incorporating biodiversity and WFD elements and listing multiple benefits received for each measure.
- planted over 30,000 trees incorporating 8ha of new woodland and over 3km of new hedgerows, all designed to slow the passage of water, and increasing river shade along 5km of river.
- produced NFM guidance leaflets to help guide and inform landowners and other practitioners, and have 2 further planned by 2018.
- engaged with, presented to, and advised multiple stakeholders including the European Commission, WWF, Flood and Coastal Risk Management teams (EA), Transition Town groups, Flood Forums, Southern Regional Flood and Coastal Committee, Rivers Trusts and local Councils.
- secured funding from Lewes District Council to support a range of NFM work and trial measures across the Ouse catchment by 2018.
- held a wide range of events, such as landowner workshops, water fairs, local resident flood forums and drop-in surgeries. Promoted NFM via presence at a variety of local events such as wood fairs, conferences and in local media..



Map 1. Sussex Flow Initiative project area, Upper River Ouse, East Sussex. Source: Sussex Flow Initiative / ordnance survey.

1. Contact details

Contact details	
Name(s):	Sandra Manning-Jones (SFI Project Officer); Gareth Williams (Environment Agency); Fran Southgate (Sussex Wildlife Trust)
Lead organisation(s):	Sussex Wildlife Trust (host)
Partners:	Sussex Wildlife Trust; Woodland Trust; Environment Agency.
e-mail address:	sandramanningjones@gmail.com Gareth.williams@environment-agency.gov.uk fransouthgate@sussexwt.org.uk

2. Location and catchment description

Catchment summary	
National Grid Reference:	Central grid ref: TQ434203
Town, County, Country:	East Sussex, United Kingdom
RFCC Region:	South East
Catchment name(s) and size (km2):	River Ouse catchment (fluvial extent) 510km2
River name(s) and typology:	Multiple tributary streams and main river sections showing multiple river types including: bedrock channels; ditch / small drains; modified urban watercourses.
WFD water body reference:	Including the non-tidal Ouse and all of its tributaries there are 22 WFD waterbodies within the project area.
Land use, soil type, geology, mean annual rainfall:	Land use: Pasture, arable, urban. Soils: wealden clay, Tunbridge greensand series. Geology: mudstones, sandstones, gault clay, chalk. Average annual rainfall = 830mm

3. Background summary of the catchment

Socio-economic/historic context

The Ouse has been historically extensively dredged and straightened for both navigation and to increase channel capacity. This means many river reaches are over deepened, disconnected from their floodplain, and lack much of the internal (woody), marginal and riparian habitats synonymous with a healthy river system.

The feeder streams of the Ouse are small and shallow wooded gill streams which are locally unique. Large areas of the catchment become flashy in times of heavy rainfall, particularly on the clay. Some of the middle Ouse tributaries are similar, whilst others are characteristic of slow-flowing lowland streams, attributable in places to historic navigational weirs. The lower reaches of the Ouse are typical lowland channels of uniform depth and flow. The river flows predominantly through soft sandstones, alluvium and clays, although the Bevern and Northend streams are notable in that they are derived from chalk springs (both winterbourne and perennial). A number of these chalk streams have associated mills and mill leat diversions.

At Lewes the river becomes tidal and significantly modified (canalised and embanked, with tidal

defences at Barcombe) to provide flood defences to Lewes and conurbations and infrastructure downstream. Floodwaters are often trapped behind these flood embankments for prolonged periods. The Ouse estuary joins the sea at Newhaven, which again is heavily modified for flood risk management, industrial use and navigation purposes.

Much of the Ouse landscape has been heavily modified over time for agriculture and for housing. Despite Sussex being the second most wooded county in England, there are still significant areas with limited woodland and hedgerow cover, and large areas of floodplain which through historic dredging and drainage have become hydrologically disconnected from the river. Intensive land uses such as arable farming and intensive dairy farming have also reduced the floodplains capillary capacity through the degradation of soils.

The flood risk problem(s)

The Ouse catchment is subject to fluvial, tidal, groundwater and surface water flooding. In terms of fluvial flooding, the towns of Uckfield and Lewes have been subject of a number of large scale historic floods, most significantly in 1916, 1925, 1960, 1974 and 2000. The year 2000 event was the worst recorded, causing extensive damage across the catchment costing an estimated £130 million. Groundwater flooding is localised to extreme events in the chalk and greensand (i.e. 2012/2013), whilst surface water flooding is increasing in both rural and urban areas. There has been a noticeable change in the frequency, intensity and seasonal range of large rainfall events. The catchment has seen a number of weather precedents set over the last 15 years, including winter droughts, summer floods, and numerous occurrences of large volumes of geographically isolated rain falling over short spaces of time.

Increased urbanisation in the catchment has exacerbated the flashiness of some parts of the river, whilst many other more rural areas flood badly, but do not have sufficient housing to put them on the Environment Agency priority flood risk register. Large amounts of flash flooding are now occurring in urban areas due to Surface Water Run Off, whilst rural areas suffer more from having transport routes and farming resources submerged by flooding.

Other environmental problems

The water quality of the river Ouse is compromised by a range of pressures, from isolated sources of pollution through to the combined effects of multiple diffuse sources, both rural and urban. Evidence driving the ecological status of the river system shows that nutrient enrichment, particularly phosphates in freshwaters (from agricultural diffuse pollution, Sewage Treatment Works and rural septic tanks), are a primary reasons for poor water quality. Other factors affecting surface water quality include increased demand for water abstraction (domestic and industrial), combined sewer outfalls, a growing (urban) population, changing land use and land management practices and the uncertainty of climate change factors.

The river has also been significantly modified over the centuries, resulting in canalisation, culverting, sub surface drainage, embanking and other hard engineering, that have served the purpose of draining land for agriculture. River flow and fluvial flooding has also been affected by the installation or removal of in-channel weirs and structures. These interventions have had an impact on the course and flow of the river and are contributing to a reduction in the ecological status of the system. As a result, fish passage is also a key issue in the catchment. In many cases bridges across the river are too small for the volumes of water that they are expected to carry and they now serve as throttles to floodwaters when they pass through.

Overall the habitat quality of River Ouse catchment wetlands is very limited. There are small and isolated patches of priority habitat in floodplains such as fen and reedbed, but very few of any notable size. Riparian and in-stream habitats are often homogenous and heavily impacted by surrounding land use. Ponds are on the whole degraded and nutrient rich, and natural topographic variations in floodplains have been largely ‘smoothed out’ over the decades, leaving limited seasonal wetland habitat.

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

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

Our initial project, TrUck, was based on a model created by Durham University called Overflow (developed by professors Nick Odoni and Stuart Lane) which highlighted a number of river reaches where addition of NFM measures in combination could lead to a reduction in flood peak. Ground-truthing and landowner engagement highlighted the difficulties with delivery, as some areas already had natural NFM measures in place (like floodplain woodland), and others were not suitable due to landuse (such as fisheries) or lack of landowner support. With limited funds to re-run the model, we subsequently focussed on ways we could maximise data and expertise to target beneficial but low risk locations, whilst gradually adding measures to key sites indicated by the Uck Overflow model. It was also clear that not all NFM measures are suited to all locations, and working at a large scale we focused on simple models that could help refine targeting. These models included:

- Compound Topographic Index of Wetness: GIS model which highlights areas that get wet first and drain last, indicating areas where we could increase or maximise water storage, or where surface water problems are likely.
- Ouse Back Water Buffers: In order to highlight areas where large blocks of woodland could increase local flooding to roads or other infrastructure due to the backing up of water, buffers were created downstream of roads or other pertinent features (i.e. Scheduled Ancient Monuments) using GIS.
- Floodplain Woodland Model: This GIS based model which incorporates a range of data (including back water buffers and inundation regimes), providing a heat map to highlight areas of the floodplain that would be most beneficial for woodland planting towards slowing the flow.
- Habitat Potential Models: Sussex Biodiversity Record Centre have created a range of opportunity maps for a nine priority habitats, such as wet woodland and lowland meadows.
- EcoServ-GIS - An Ecosystem Service model for nine priority ecosystem services including water purification run for the Ouse by the Sussex Biodiversity Record Centre.

Additional evidence has been gathered using:

- Sub-catchment walkover surveys and mapping. Working with OART, and in recognition of the need to combine and analyse existing data, we have developed a methodology to assess opportunities of NFM with multiple benefits. This incorporates River Habitat Surveys, water quality testing, landuse, historic land use, habitat connectivity and ecosystem service models (EcoServ-GIS). This provides an opportunity map of all measures possible, and highlights which would be most beneficial in terms of flooding, water quality or ecosystem service provision for example. Upon completion of each sub-catchment area landowner workshops will be held to deliver and promote these outcomes.
- Rural Un-protected Properties: We are working with the EA flood risk managers to see how NFM could help increase protection to rural properties at risk of flooding that do not have or cannot benefit from traditional flood protection.
- Academic partnerships. We have worked with, and are building on a number of local and national projects with academia to exchange data, build knowledge and expertise.
- National datasets. National targeting of water protection areas, and flood areas, as well as Water Framework Directive, Keeping Rivers Cool and other target mapping have all informed our work.
- Local datasets. Species and habitat evidence as well as local knowledge have been used to highlight issues and to inform solutions.
- Uckfield Flood Forum: Momentum for our pilot project, TrUck, was generated by members of the Uckfield Flood Forum as a result of by the Knowledge of Environmental Controversies group which engaged the community about ways to reduce flood risk. This work highlighted the impracticalities of more hard engineered solutions (such as creation of a reservoir), and led them to look at other solutions.
- Environment Agency Catchment Flood Management Plans. The majority of the upper Ouse

catchment is designated as an Environment Agency 'Policy 6' area: "Areas of low to moderate flood risk where we will take action with others to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits", which supports the use of NFM.

- Landowner liaison. Significant pieces of work have often come about opportunistically through work with landowners.
- Sussex Ouse Meadows Project. An ongoing project to survey and map floodplain meadows and woodlands in the Ouse.

At various stages of the project we have reviewed our progress via discussion and engagement with expert panels, teams within the Environment Agency, key academics and other national and European NFM projects.

We believe that local people and other stakeholders have become convinced that NFM is a viable option through:

- Local engagement – people 'seeing with their own eyes', getting involved in River Habitat Workshops etc.
- The presentation of common sense facts, backed up by evidence.
- Visual presentation of maps and evidence.
- Demistification of how water and flooding works locally, and what the potential solutions are.
- Seeing that localised engineering solutions work to a point, but that greater benefits can be derived in the long term by using multiple methods of flood risk management across the landscape.
- Seeing there is no 'one size fits all' solution, and that each location and case is unique in its sources and solutions.
- Because they are able to usefully contribute to doing something about the issue.
- Seeing that NFM can have multiple benefits for the community and the environment.
- People's desire to plant hedgerows. This is our single most popular NFM measure (but difficult to fund).
- The accessibility of low cost, simple solutions to flooding.

Urban SUDS are slightly more problematic and a lot more costly. We currently do not have the resources (staff or financial) to go through the necessary planning applications and iterations to install SUDS. We do advise on their location however, and provide as much support as possible.

What was the design rationale?

Due to the scale of the project (whole river catchment), we have spent time understanding the landscape and hydrology of the different constituent parts of the landscape. This has included a range of modelling and mapping exercises.

Our initial project rationale was to deliver outputs of the River Uck 'Overflow' model. Once we understood the difficulties with not only delivering these outcomes but also in commissioning a new model (particularly the cost), we focussed on ways we could reduce flood risks in other ways and in other locations. The idea of the project was to install and test a range of NFM measures, across a range of different landscapes, to see if NFM could work at a catchment scale. We also sought to enhance the multiple benefits accrued from NFM, which meets the broader agendas of SFI project partners.

With the Woodland Trust as a key partner, one of our focus areas has been tree planting. Our woodland planting follows the National Forestry Standard. Much of this new woodland has been small in size (approx. 1ha patches) and therefore requires less planning than larger sites. Hedgerows have also been a focus, and where possible, hedgerows are restored on historic hedge lines, and across slopes or floodplain fields.

To date we have trialled woody dam designs in low risk locations, using local and natural materials.

Designs of these small dams was influenced by work by the Slowing the Flow at Pickering project. We have subsequently developed a range of different dam designs to suit different locations and maintain environmental flow. Experimental and 'case study' NFM measures were initially installed on project partner properties where they can be showcased to others.

We are developing other trial sites for different measures such as flood storage ponds and washland meadows for delivery by 2018.

We have advised a range of landowners on the reduction of surface water flows and run-off.

Our sub catchment plans will be presented to the catchment partnership and will be used to support the creation of a wide range of NFM and WFD measures across each sub catchment.

Project summary	
Area of catchment (km2) or length of river benefitting from the project:	Upper (fluvial) River Ouse catchment = 510km2 Length of Detailed River Network = 1100km
Types of measures/interventions used (both WWNP and traditional):	Floodplain woodland; hedgerows; shelter belts; flood storage ponds; woody dams; washland meadows.
Numbers of measures/interventions used (both WWNP and traditional):	At 2016: 8ha woodland; 3km hedgerows; 10 woody dams.
Standard of protection for project as a whole:	Not yet known.
Estimated number of properties protected:	Not yet known.

How effective has the project been?

In terms of our three strands of work, Demonstration, Advocacy and Signposting:

Demonstration

We are not yet able to quantify our impact on flood peak in the River Uck or wide Ouse, partly due to the time it will take for NFM measures such as woodlands and hedgerows to become fully functional. Also we will continue to add further measures over the next few years and beyond (funding dependant). We have however installed a number of NFM measures, all of which we are certain have had no negative impact on flooding, and the majority of which we believe have had a positive impact on flooding (i.e. through surface water interception). Unfortunately there is limited hydrological monitoring across the catchment, so we are unlikely to ever be able to provide exact figures on the extent to which our NFM measures will reduce flooding. We have completed detailed assessments of two waterbodies, highlighting opportunities for multiple benefits measures, and we have funding for a further five sub-catchment areas. We have undertaken trials to better understand the use of woody dams and impacts on geomorphology. Whilst we have not yet reported on this work, rapid and extensive sediment accretion means that there are further implications of this type of work which need to be assessed. We have plans in place for more extensive woody dam trials along with flood storage ponds and washland meadows. We are building up a suite of case study examples of these and other measures such as land drainage reduction. We are advocating and evidencing multiple benefits work such as ecosystem service provision and climate change mitigation.

Advocacy

We have been extremely effective in influencing local (and national) use and understanding of NFM, engaging with well over 30,000 people over the course of the project, and influencing others through media and internet. We have consulted and advised others to use NFM in two other Sussex catchments. We have mobilised local community groups to look at Sustainable Urban Drainage solutions and Natural Flood Management to reduce local flooding issues. We have also contributed to work at a European level. We have worked in partnership with a range of key organisations including

catchment partnerships and rivers trusts.

Signposting

We have drawn up guidance notes on how to deliver NFM, specifically woody material in rivers, and floodplain washlands. We are continuing to work with academic institutions to develop research into the efficacy of different NFM measures. We have active and popular websites which host a range of information and useful links on flooding and NFM. We are using our modelling and mapping work at a landscape scale to help local people to effectively target NFM and multiple benefits measures to appropriate areas of the landscape. We are regularly used as a point of reference for guidance on NFM

5. Project construction

How were individual measures constructed?

Small woody dams constructed in woodland ditch / stream network using materials from site, and volunteers. Dams were designed to allow some water passage underneath the dam.

Other measures (e.g. flood storage ponds; washland meadows) in planning for delivery 2017/8.

Trees and hedgerows all planted with help from local volunteers, and planting guidance provided via the National Forestry Standard. Deer guards are necessary for all sites in the Ouse catchment, and mesh guards were used for all floodplain sites.

How long were measures designed to last?

Monitoring of decay of trial woodland dams ongoing. After four years dams remain in place, and wood used (alder and hazel) remains intact.

Advice given on long-term maintenance of trees and hedgerows, and agreements in place to prevent removal for next 12 years.

Where there any land owner or legal requirements which needed consideration?

- Flood Defence Consent applications were made for floodplain and river bank planting, and will be made for the creation of wader scrapes and other temporary flood storage features.
- Full Planning Consent is being sought for our flood storage ponds.
- Full assessment of local designated sites and other important habitats / features was undertaken for every site (to ensure no damage to existing biodiversity or ecosystem services)
- Botanical surveys were undertaken at key sites to ensure net gain in terms of habitat provision.
- Landowners neighbouring trial sites were consulted where required.
- Landowners were advised on streamlining NFM work with existing grant schemes such as CS and FC grants.
- Reassurance was given to landowners that they can remove NFM measures if they can be shown to have exacerbated flooding (this hasn't been necessary yet).
- Data agreements have been made to ensure the legal restrictions on the use of mapped data are adhered to.
- Health and Safety protocols and insurance are provided for volunteers and staff.

6. Funding

Funding summary for WWNP/NFM measures	
Year project was undertaken/completed	Started 2012 / funded until 2019.
How was the project funded:	Funding from multiple sources, covering different time periods and focus. Funders (listed by contribution with largest first): Environment Agency, Woodland Trust, Sussex Wildlife Trust, Lewes District Council, Royal Bank of Canada, private charitable donations, Adur and Ouse Catchment Partnership.
Total cash cost of project (£)	Funding 2012-2017 Funds received = £235,000 In-kind contributions = £105,000
Overall cost and cost breakdown for WWNP/NFM measures (£)	Woody dams = staff and volunteer time only. Woodland = approx. £30000 over 5 years. Hedgerows = approx. £15000 over 5 years.
WWNP/NFM costs as a % of overall project costs?	Between 20-30% of costs up to 2017. Estimated 30-40% 2018-2019.
Unit breakdown of costs for WWNP/NFM measures:	Not yet known.
Cost benefit ratio (and timescale in years over which benefit cost ratio has been estimated)	Not yet known.

7. Wider benefits

What wider benefits has the project achieved?

- All of our woodland and hedgerow sites have been planned to enhance river health, ecosystem service provision, ecological networks and to contribute towards WFD targets. This has been achieved using GIS mapping and data, including historic maps. These sites will also contribute to water quality enhancement, air quality enhancement, noise pollution reduction, climate change mitigation, green space provision etc.
- We have informed two new NFM projects in other Sussex catchments.
- Ecosystem services mapping can now help us to articulate the multiple benefits of NFM sites using the EcoServ-GIS model. We have delivered NFM planting on areas identified as high risk in the Keeping Rivers Cool for climate change mapping
- We have delivered NFM measures in national target areas for water quality and flood reduction
- We have influenced local communities to reduce flood risk through NFM & SUDs.
- NFM measures have been targeted across failing WFD catchments to maximise water quality benefits.
- Hedgerows and other habitats have been targeted to areas where they will increase biodiversity benefit and landscape connectivity for target species such as bats.
- Tree planting has been used as source protection for spring heads.

How much habitat has been created, improved or restored?

- We have engaged with and given advice to landowners covering nearly 70km of the river network.
- We have increased river shade and reduced bank erosion on 5km of river.
- We have plated over 3km of hedgerows, and planted approx 8ha of new woodland incorporating over 30,000 trees.

8. Maintenance, monitoring and adaptive management

Are maintenance activities planned?

All hedgerows and trees are supplied with specific guidance for future maintenance, and an agreement to maintain NFM features must be signed by the landowner prior to planting.

For other measures, such as Flood Storage Ponds, maintenance agreements will be made with the landowner, and help will be provided by project partners where possible. We hope to train landowners to understand how to spot when measures are no longer functional.

We envisage that individual landowners are responsible overall for the monitoring and maintenance of NFM measures, and where possible we provide guidance on adaptive management.

Is the project being monitored?

Fixed point photography is being used on a number of planting and woody dam sites.

We have supported, and have plans for, a range of student projects, including MSc and PhD level research.

Hydrological impacts will be assessed using extensive and historic gauges, however due to timescales and funding we do not currently have the capacity to plan this far ahead. This will be factored in as the project develops.

We are currently researching different models relevant to NFM in order to see if we can answer some specific questions (e.g. how much storage or delay could be increased in existing Ouse woodlands).

We are gathering mapped (habitat and other) data which can be used for monitoring long term landscape change.

We map landowners advised, and maintain contact where we can.

Has adaptive management been needed?

Our trials using woody dams in woodland ditches have informed further work to retain low flows and encourage the creation of more natural flow channels where ditches have rapidly accumulated sediment.

A small number of dams were also moved by floodwater during a recent summer flash flood, which produced flows well in excess of expectations. We have subsequent plans to increase the size, and reduce the mobility of these dams to reduce the potential for future washout.

9. Lessons learnt

What did you learn and how could it be applied elsewhere?

- One of our greatest boons has been the support of our project partners (Sussex Wildlife Trust, Environment Agency and Woodland Trust) who all share an underlying belief in NFM and the need to start this work now, without seeing immediate benefits. Partnership work with other

organisations, projects and groups, along with volunteer and community support from local people has also helped us make progress.

- When local people feel educated and empowered to do something positive to reduce flooding, with the support of NGO's and statutory organisations, they are very keen to participate.
- Having a project officer, who is a trained and trusted advocate of NFM is a priority. They provide an accessible point of contact for advice, funding and support.
- Long term funding is an issue. Both funding for staff time, and for NFM delivery is limited and difficult to acquire.
- It takes time to build relationships of trust with landowners and stakeholders It is clear from our work in the Ouse that voluntary take up of NFM measures, particularly those that change landuse or have implications on hydrology, is not overly forthcoming, and it takes time to encourage landowners to participate. Landowner support often radiates out from one landowner to neighbouring properties over following years, and often leads to larger schemes and opportunities.
- Opportunities for NFM are often small in size (though cumulatively large across a landscape).
- Lowland NFM is not a 'one size fits all' approach, however the range of techniques available offers options at most sites.
- It helps to articulate clear and multiple benefits to landowners, such as wildlife enhancement, better water and soil management and wood fuel benefits.
- Working at the catchment scale in a lowland and heavily populated area with complex land ownership it is important to develop a detailed understanding of the characteristics of different areas, and the mechanisms influencing local or wider flooding. This involves a great deal of work, time, and demands understanding of a range of different disciplines such as ecology, hydrology, geomorphology, weather patterns and geology.
- As the majority of landowners are only willing to undertake small scale measures an even greater number will be required to evoke a significant reduction in downstream flood peak. This has cost / benefit implications as each site takes time to plan regardless of size.
- At this stage of our project it is much easier to quantify the other benefits accrued from our NFM measures, such as water course protection or habitat creation – and we have been able to gain further funding based on these benefits.
- Landowner support often radiates out from one landowner to neighbouring properties over following years, and often leads to larger schemes and opportunities.
- Consulting with local at risk communities, landowners and local groups should be commenced as soon as possible. This helps garner local support, but also provides a great deal of pertinent local information which can be otherwise difficult to find.
- Current, comprehensive and continuous river survey data is vital.
- Catchment Scale: In order to target, plan and instigate NFM measures you must understand your subject area in detail. At the catchment scale it is not possible to measure the gradual addition of small NFM measures. It is therefore essential that the catchment is broken down into smaller areas. Some areas are better suited to particular NFM measures than others (e.g. woody dams in very steep headwaters may not be as effective as those at less steep gradients), however it is possible to use catchment data and knowledge to help effectively target individual measures.
- Floodplain woodland: The majority of Ouse landowners only want small areas of planting (<1ha). As such these are likely to carry little risk, but we will need to plant a large number in order to evoke flood peak reduction. Where roads or other infrastructure may be negatively affected by water impoundment caused by large blocks of woodland, downstream buffers can be easily applied using GIS. Stakeholders concerned about increasing flood risk through addition of NFM found this work particularly persuasive in supporting NFM.
- Woody Dams: Woody structures that are situated within the stream or channel rapidly accrete sediments, losing profile. During times of low flow in summer months in smaller streams or ditches step change created behind dams can lead to pooling and potentially increased eutrophication. We have subsequently developed a range of different designs for different locations, some of which only interact with the water course during times of high flow.
- Landowners generally support NFM measures based on other benefits accrued, such as wood fuel

or water protection, as opposed to helping to reduce flooding for downstream communities.

- The term ‘woody debris dam’ causes a bad reaction in some due to entrenched beliefs in the importance of removal of in-channel wood.

10. Bibliography

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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.

Project manager: Lydia Burgess-Gamble, Evidence Directorate

Research contractors: Steve Rose (JBA), Steve Maslen (JBA), Rachelle Ngai (JBA), Barry Hankin (JBA), Robert Harvey (JBA), Keith Beven (Lancaster University), Trevor Page (Lancaster University), Mark Wilkinson (James Hutton Institute), Paul Quinn (Newcastle University), Greg O’Donnell (Newcastle University) and Tom Nisbet (Forest Research).

For more information contact: wwwp@environment-agency.gov.uk