Workshop report: Identifying data, evidence and modelling requirements to develop a catchment strategy for sediment and flood risk

Skell Valley Project

July 2019

Executive summary

The Skell Valley project, led by the National Trust, aims to restore habitats, conserve historic features, increase community access and reduce flood risk to Fountains Abbey and Studley Royal Water Garden, a World Heritage Site that has been significantly impacted by flooding and siltation.

The approach to flood risk management will focus on soils, sediments, morphology and natural flood management (NFM).

JBA Trust worked with the National Trust to help identify the data and modelling needs, and the robustness of evidence, for developing NFM strategies in the Skell catchment to reduce flood and sediment risks.

We held a workshop and invited experts from a wide range of organisations including academia, government, the community and industry.

The workshop structure was designed to meet the following objectives:

- Provide background to achieve a shared understanding of what the Skell Valley project is trying to deliver and why.
- Share the latest scientific evidence base for nature-based flood and sediment/erosion risk management.
- Identify what data and knowledge is needed, and what already exists, that will be relevant and available to inform catchment planning in the Skell including modelling, data sets, previous research and locally-held knowledge.
- Explore knowledge gaps and uncertainties to understand what questions need to be answered and how we might answer them.
- Identify which stakeholders the project will need to engage with.
- Capture agreement and commitments on actions and next steps to set the direction of the catchment plan.

The input of a professional facilitator to the design and delivery of the workshop proved valuable in gathering the required information from participants within a limited time.

We hope that this report could be useful as a design template for similar workshops aiming to identify what data, evidence and modelling is needed to create a NFM plan.

Contents

1 Background

Following a successful bid for funding from the National Lottery Heritage Fund, the National Trust and Nidderdale AONB embarked on the first stage of the Skell Valley Project in July 2019.

Along with people from the local community, landowners and farmers from the river catchment, the project will involve restoring habitats, conserving historic features, introducing natural flood management (NFM) and improving access to hidden corners of the Skell Valley's landscape.

The NFM part of the project aims to reduce soil loss, sedimentation and flooding in the Skell catchment. The damage caused by flooding and siltation at the World Heritage Site of Fountains Abbey and Studley Royal Water Garden has cost the National Trust around £2.5 million since it acquired the site in 1983. Residents of Ripon were also affected by flooding in 2007 with some being evacuated from their homes.

On 9 July 2019, the National Trust, supported by the JBA Trust, convened a workshop with the aim of building a shared understanding of the data and modelling needs, and the robustness of evidence, for developing NFM strategies in the Skell catchment. The underlying driver and context for the workshop was to reduce flood and sediment risks, with a particular focus on soils, sediments, morphology and NFM.

This report aims to summarise the process of identifying what data, evidence and modelling is needed to create a NFM plan. We hope this knowledge is transferable and can be shared to support other catchment groups planning similar interventions to mitigate sedimentation and flooding risks.

2 Workshop structure

Session A	Welcome and introductions
Session B	Understanding the background, ambitions and values of the project Aims: Achieve a shared understanding of what the project is trying to deliver and why
Session C	The evidence base for nature-based flood and erosion risk management Aims: Share views on the scientific state of knowledge and evidence about catchment nature-based flood and sediment management
Session D	Capturing data in the Skell catchment Aims: To gain an overview of what data and knowledge is needed, and what already exists, that will be relevant and available to inform catchment planning in the Skell. This includes modelling, data sets, previous research and locally-held knowledge.
Session E	Exploring knowledge gaps and uncertainties Aims: To understand what questions need to be answered to support the development of a catchment management strategy.
Session F	Involving stakeholders Aims: Identify which stakeholders the project will need to engage with to address the problems in the catchment captured during the previous workshop sessions. This exercise will inform the stakeholder plan for the next planning and implementation phase of the project.
Session G	Identifying actions and next steps: Aims: To capture agreement and commitments on actions that will be informed by the workshop to set the direction of the catchment plan.

Attendees included representatives from the National Trust, JBA Trust, Environment Agency, Yorkshire Dales National Park Nidderdale AONB, University of Leeds, Lancaster University, University of Glasgow and JBA Consulting.

The workshop was facilitated by Dee Hennessey.

3 Understanding the background, ambitions and values of the project

Aims: To achieve a shared understanding of what the project is trying to deliver and why.

Format and content: Presentation from project lead (David Hargreaves, National Trust). The key points from the presentation are outlined below:

Background

- The World Heritage Management Plan identified silt and flood risk as threats to the World Heritage Site. One of the key objectives of the management plan is to work beyond the site boundaries to connect with communities up and downstream of the site.
- A series of workshops were held in 2016/17 with partners including Nidderdale AONB, Historic England, Environment Agency, YDRT, Natural England to discuss issues and ways forward. Additional community workshops, meetings and surveys were held in early 2018 to inform an HLF bid. In September 2018 the bid was successful (£128,000 grant match funded by National Trust and AONB to develop project to Round 2 bid)

Ambitions of the project

Addressing the sediment and flood risks is one element of the Skell Valley Project which includes four key themes:

- Getting people's hands dirty
- Awakening people's passion
- Saving the Skell Valley's natural and cultural heritage
- Managing land differently

Catchment orientation

Figure 1. Map of the project area presented at the workshop

Project timescales

The key threats and opportunities that are driving delivery of the project within the timescales outlined below include:

Threats	Opportunities
• Flooding and siltation at key sites along the river • Some heritage features and landscapes are neglected and in poor condition • Water quality impacts on river wildlife • Encroachment of invasive species	• Countryside Stewardship NFM Facilitation Fund Farmers Network set up • Community enthusiasm • Ripon City Plan & developments in Ripon • Grantley Hall hotel and spa • Establishment of Hell Wath Friends group

Winter 2018 to July 2020
Develop project

July 2020
Submission of Round 2 bid for £2.4m delivery costs

2020 to 2024
Delivery of project


Photo credit: Zora Van Leeuwen

4 The evidence base for nature-based flood and erosion management

Aims: To share views on the scientific state of knowledge and evidence about catchment nature-based flood and sediment management.

Format: Presentation from technical expert (Barry Hankin, Head of Environmental Modelling JBA Consulting and Visiting Researcher at Lancaster University).

The presentation introduced the key concepts of nature-based measures, illustrated below:

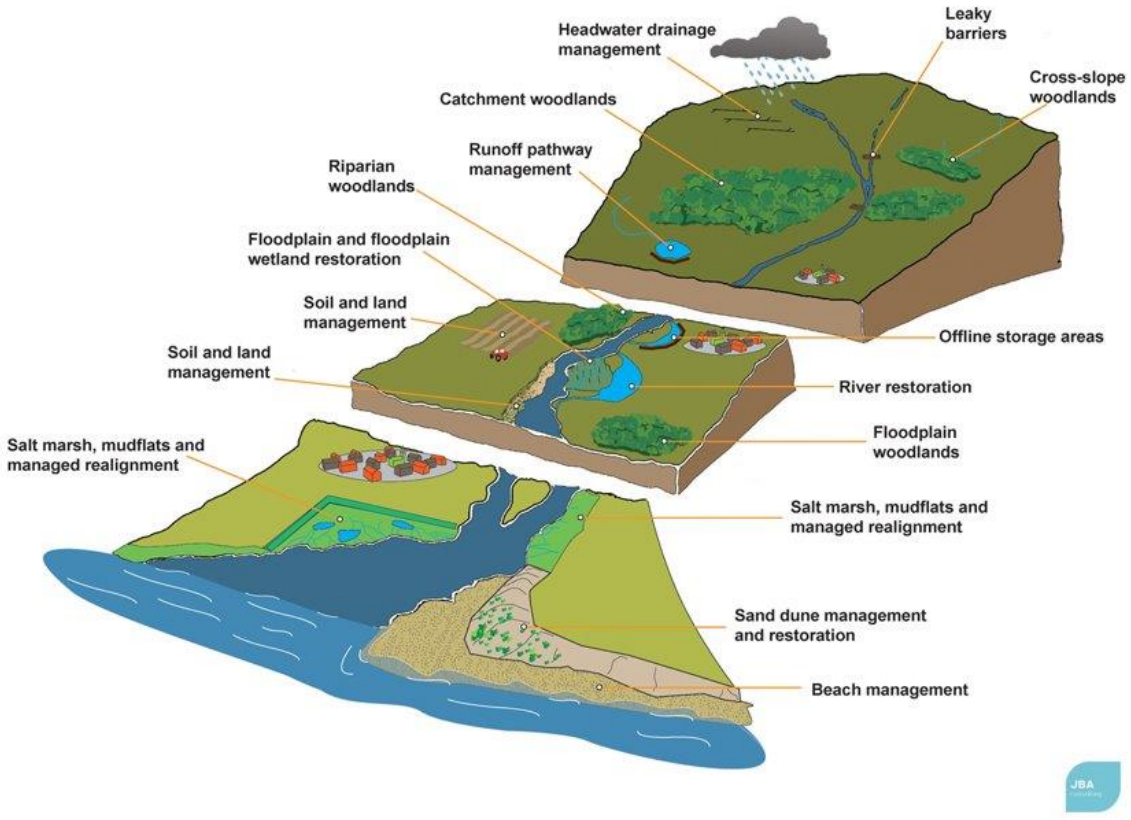


Figure 2. The key concepts of nature-based measures

Recent evidence reviews (Dadson, 2017) found that the risks associated with small floods in small catchments may be significantly reduced by nature-based approaches, although the evidence does not suggest a major effect on the most extreme events due to large fluvial floods being primarily caused by heavy rainfall on wet, frozen or impermeable ground.

A substantial knowledge base has been published by the Environment Agency (Working with Natural Processes Evidence Directory), yet there are significant evidence gaps, compounded by lack of long-term monitoring that can deliver accurate measurement of high water levels and out of bank flows. The lack of monitored baselines and experimental control also creates risk that the wider and scale dependent impacts cannot be properly investigated.

There are currently three NERC NFM projects setup to address evidence gaps and to understand effectiveness of NFM at large scale:

- Q-NFM (Lancaster) https://www.lancaster.ac.uk/lec/sites/qnfm/
- LANDWISE (Reading) https://research.reading.ac.uk/nerc-nfm/landwise-nfm/
- PROTECT (Manchester) https://protectnfm.com/

Practitioner toolkits are available to share practical experience, paying attention to design criteria. They include a protocol for coordinated high quality monitoring of the catchment, river corridor and hydro meteorological conditions using modern technology.

Current evidence the cost effectiveness of NFM at medium large scale is likely to rely on interactions between flows, debris, and sediment management taking into account a range of ecosystem benefits that accompany NFM.

5 Capturing data in the Skell catchment

Aims: To gain an overview of what data and knowledge is needed, and what already exists, that will be relevant and available to inform catchment planning in the Skell. This includes modelling, data sets, previous research and locally held knowledge.

Format: The group was divided into two smaller groups of about nine people, each group was asked to consider two questions whilst using different resources

Questions

1. What data do you think we need?
2. What assessment/modelling do you think is needed?

Resources

- A0 map of the catchment
- Interactive iTable showing topography and existing modelling of flood risk and sedimentation

Answers to the questions were captured on white boards (Figures 4 and 5).

Halfway through the session the groups swapped resources to cross reference and add to each other's outputs.

Figure 3. The interactive iTable

What data do you think we need?

- Shallow water bathymetry
- Catchment DTM (2m, possibly more detail for any experimental small sub-catchments)
- Dredging
    - volume
    - dates
    - grain size distribution
    - location of sediment accumulations
- NFM WwNP "opportunity" map layers
- Historical land management maps, reports, data
- Drainage network e.g. road drains, field drainage
- Re-survey to monitor morphological change
- Stakeholder views on opportunities/constraints for RAFs and woodland
- Rainfall
- Water levels
- Flows

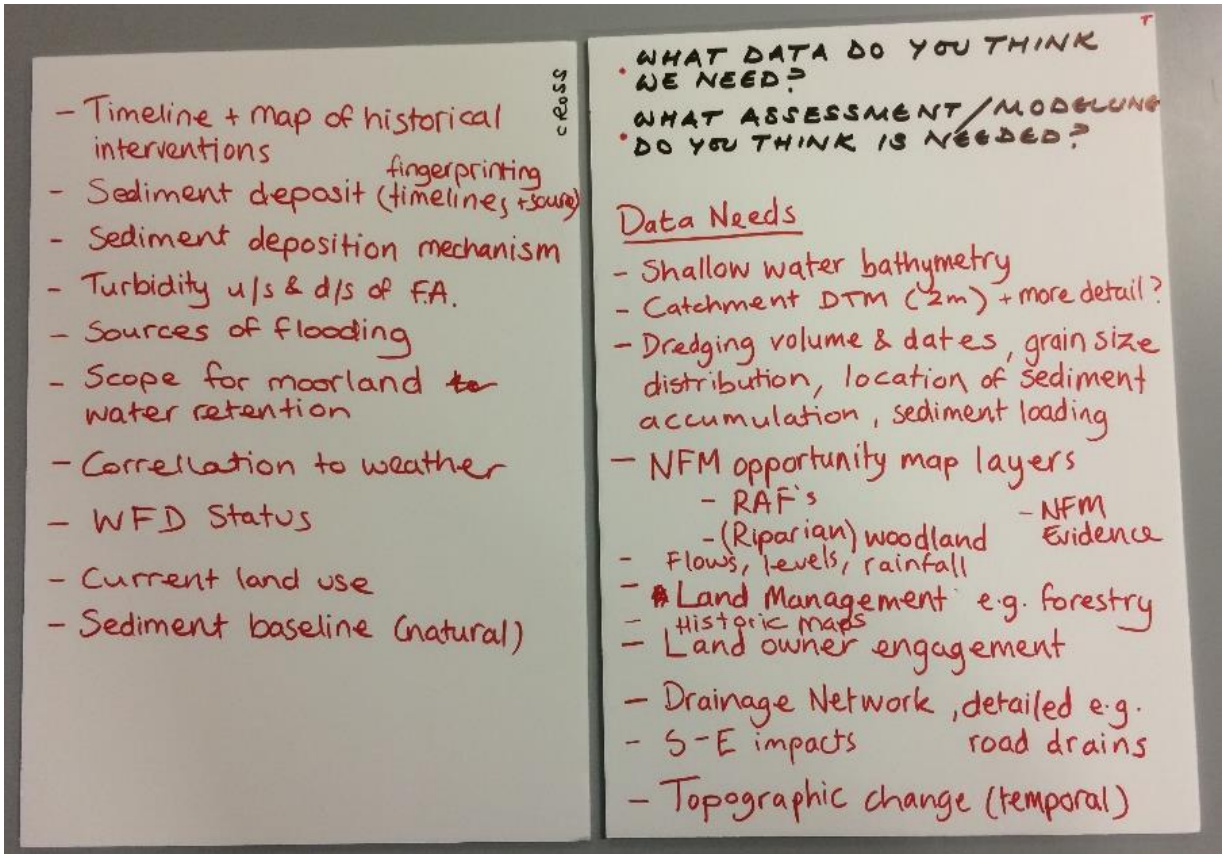


Figure 4. Workshop answers to 'what data do you think we need?'

What assessment/modelling do you think is needed?

- Rainfall-runoff modelling (and calibration)
- 2D hydraulic modelling
- Derived shear stress analysis for erosion and deposition potential
- Uncertainty assessments
- Before/after modelling of intervention scenarios
- Landscape evolution (hydrology plus geomorphology) model
- Spatially distributed sediment budget
- Fluvial audit (walk over)
- Budget
- Multi-grain size sediment modelling
- Past and potential scenarios of land ownership and land use
- Ecological status
- Soil management approaches
- Timescales for future interventions

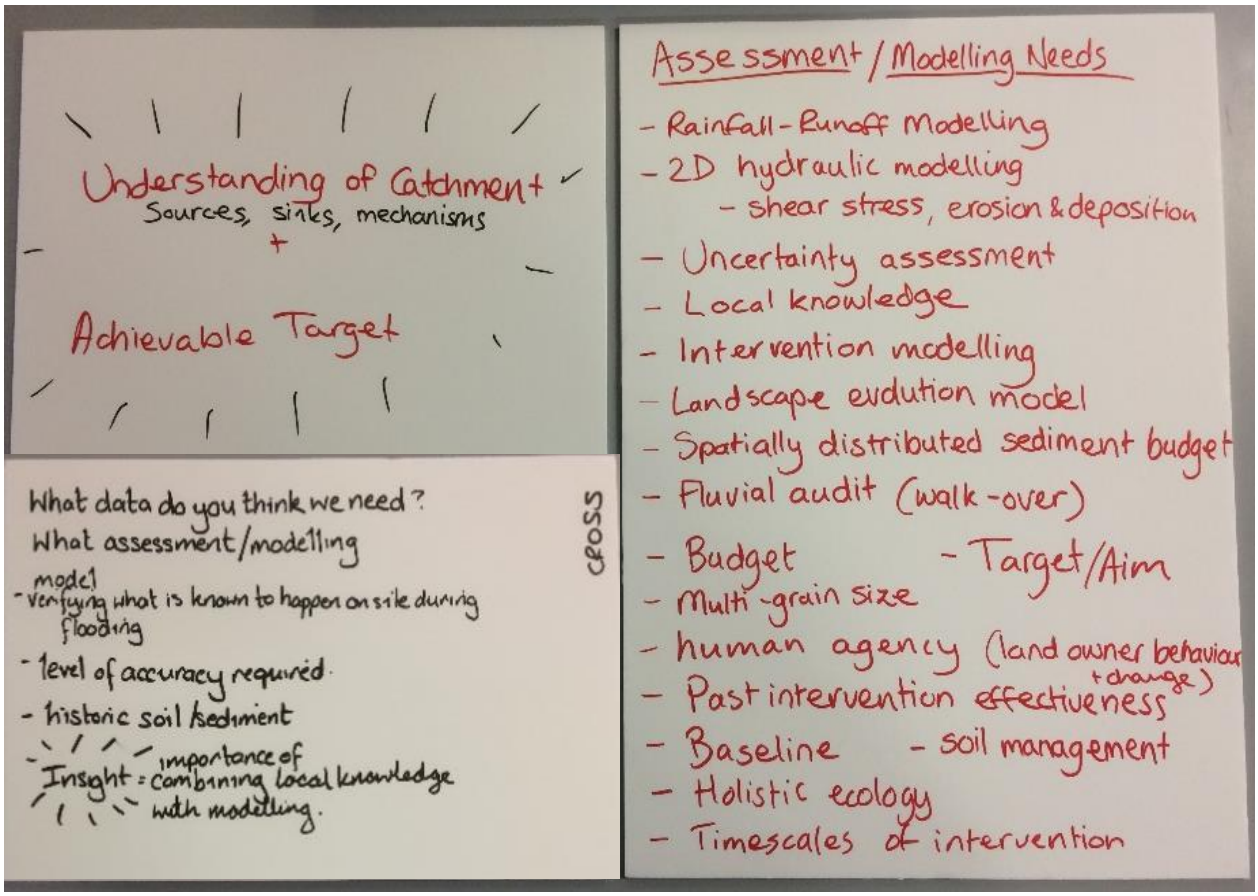
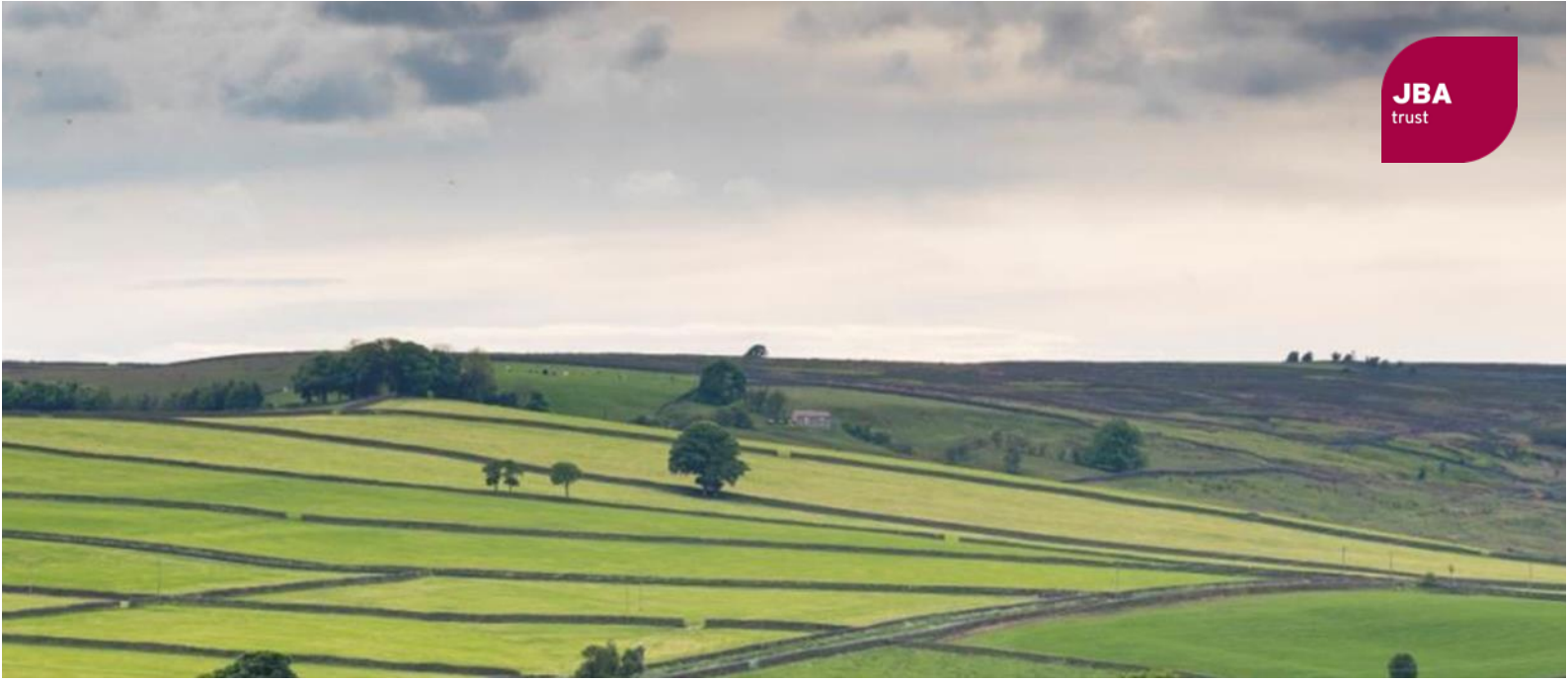


Figure 5. Workshop answers to 'What assessment/modelling do you think is needed?'



6 Exploring knowledge gaps and uncertainties

Aim: To understand what questions need to be answered to support the development of a catchment management strategy.

Format: The group was split into three smaller groups. Each group was tasked with identifying and summarising different categories of knowledge gaps and uncertainties:

1. Data, observation and monitoring
2. Effectiveness and performance of interventions
3. Sediment budget and dynamics

Each group was then given the opportunity to move to the other categories to add to add their thoughts to the flip charts.

6.1 Outputs from the workshop

The following sections summarise the findings captured by flip charts and in plenary discussion. The knowledge gaps and evidence needs are organised by the categories given above, and attributed with an indication of how each evidence need could be met.

The resource effort and time required to address evidence needs satisfactorily is difficult to determine precisely. Most activities can be scaled to reflect the level of ambition of a programme of catchment change. A general observation, informed by discussion during and after the workshop, is that time spent on initial engagement with a group of technical experts is helpful in sharpening the scope of what can be achieved and refining the ambition.

A recurring issue is that there can be a tension between motivations and opportunities to press ahead with actions (to “make things happen on the ground”) versus the time needed for evidence gathering to support a full assessment of the impacts of change. It can be time-consuming to establish a baseline to enable comparison with future observations, and hence an objective evaluation of the benefits of a project.

A particular challenge for projects seeking flood risk management benefits is that floods are rare events, and so, by definition, a long period of baseline monitoring will usually be needed to establish an understanding of "pre-project" risk. This problem can be ameliorated to some extent by reference to established, long term measurement programmes (such as the established river gauges). In some cases, there may be experimental studies or research surveys that can help.

In the Skell catchment there are, fortunately, aspects of both. The workshop discussion helped to reveal what information could already be used to form a baseline understanding. It was also noted that whilst long term monitoring may be an obvious (but impractical) strategy to establish baseline conditions, much can also be done using computer models, especially where those models can either be calibrated on "snapshots" of baseline data such as short term temporary river gauges and spatial data, or extrapolated from other, similar catchments.

6.1.1 Data, observation and monitoring

Table 1. Summary of how to address knowledge gaps and uncertainties

Question/evidence need	How to answer
Need a monitoring and data strategy to define what will be measured/observed, where, when and how often, and how will the data be stored and made available	Desk-based, outline during feasibility project, develop in full during catchment management plan implementation phase
Monitoring of key physical variables: • rainfall, • water levels (river, lake, NFM features), • water flow, • turbidity, • sediment concentration, • sediment volumes, • temperature, • windspeed, • evaporation, • soil moisture, • flow pathways, • erosion and deposition locations, • changes in river ground levels, riverbanks, and channel beds.	Combination of: • install and maintain in-situ measurement stations • derive from public-domain data (e.g. Met office, Environment Agency) • walk-over surveys
Capture "informal" local knowledge to help in testing models.	Through stakeholder consultation and literature gathering
Need to ensure consistency of measurements, data capture and data storage	Specify measurement and data storage protocols during implementation phase

Historical context is important, especially for extreme events like floods	Desk-based study
A BACI (Before/After and Control/Impact) design is widely accepted as a rigorous research protocol. Plan to include some pre-intervention monitoring and "untreated" locations to provide baseline and control data.	Consider BACI design principles in development of catchment management plan. If pre-intervention monitoring is impractical or can only be achieved for a limited time, consider monitoring at existing locations that can be shown or reasonably expected to be like the subject locations. Consider monitoring at multiple control sites for comparison with the "intervention" site.

6.1.2 Effectiveness and performance of interventions

Storage-based runoff attenuation features (channel or hillslope) e.g. leaky barriers, earth bunds:

- What are the maintenance needs?
- Who has ownership, responsibility and liability? Might payment mechanisms create a situation where owners are being paid to create a liability?
- How to choose an appropriate height/size and potential for runoff storage?
- What are the operational and maintenance needs?
- Can they turn into sediment traps?
- Longevity and deterioration rates
- Failure modes and probabilities
- Rates of erosion or deposition

Tree planting:

- Different desired mechanisms on hillslopes (increase infiltration, wet canopy evaporation, reduce runoff production) and floodplains (increase roughness, slow the flow)
- How will trees affect water flow at different stages of development?
- Influence of species type, planting density, maintenance?

Headwater peatland restoration:

- What is the timescale for benefits to be achieved?
- How far downstream will benefits be felt?

Ambition and Specification:

- What magnitude of flood event is considered in planning? What is the desired scale of risk reduction?
- What locations and scale of implementation is achievable practically?

6.1.3 Sediment budget and dynamics

Sources:

- Where does the sediment come from? Where does erosion occur?
- What are the grain size distributions in different parts of the catchment?
- What is the role of flood events in the sediment budget?

Pathways:

- How do sediment fluxes vary through the catchment and over time?
- What are the pathways for sediment flux?
- Where are the intermediate stores within the catchment?

Sinks:

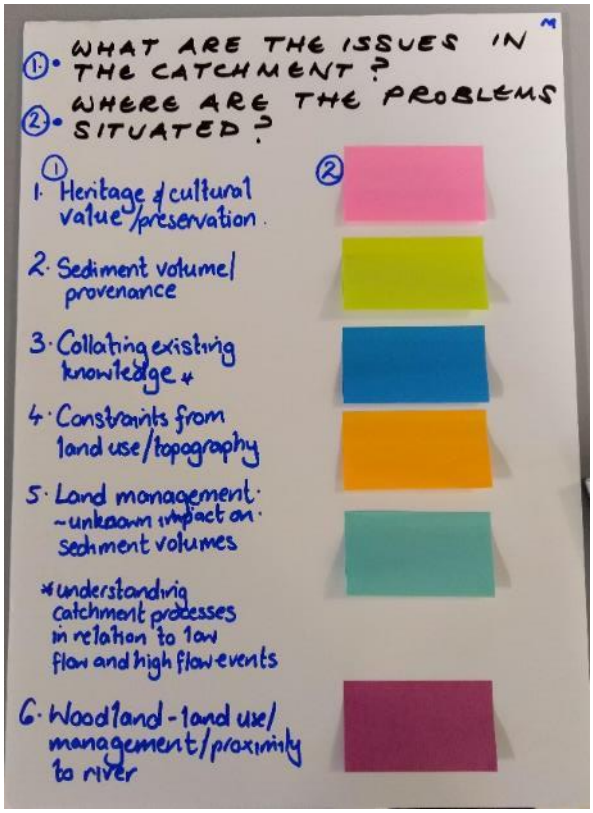
- What is the composition of past sediment deposits?
- Can we reconstruct past deposition rates and sediment budget from historical deposits and flood history?
- Is there other historical evidence? e.g. records of previous dredging activities?
- Are there sediment deposits downstream of the catchment that may be useful for analysis?

Observations:

- Turbidity sensors can be installed in a network within the catchment
- Sediment fingerprinting
- Isotope analysis

7 Stakeholder mapping

Aim: To identify which stakeholders the project will need to engage with to address the problems in the catchment during the previous workshop sessions. This exercise will inform the stakeholder plan for the next planning and implementation phase of the project.



Format: Using the colour coded chart shown in Figure 6 as a key, the group identified stakeholders that could help address each of the six specific issues in the catchment, summarised on a post-it and added this to the catchment map.

Figure 6. Stakeholder mapping key

Table 2. Stakeholder mapping outputs

Issue	Stakeholders
Heritage and cultural value/preservation	Historic England English Heritage (responsible for conservation of Abbey and Mill) Schools, future generations Ecologists Tourists, visitor attractions UNESCO Canal & Rivers Trust (Ripon Canal) Local residents Local Economic Partnership (LEP) – business / tourism Estate owners (Eavestone, Grantely Hall, Dallowgill) General public / taxpayers
Sediment volume/provenence	LEP Landowners and farmers Highways Agency Environment Agency Natural England iCASP Citizen science volunteers Planning authorities Local council, District and LLFA (NYCC) Modellers
Collating existing knowledge (understanding catchment processes in relation to low flow and high flow events)	AONB National Trust Local knoweldge e.g. Ripon residents, farmers, landowners Environment Agency Yorkshire Water Students looking for research projects .gov.uk website for open data, hydrometry and event data Project managers → evaluation of project Academics
Constraints from land use/topography	Landowners Natural England Local politicians / MP Media / press Consumers of agricultural produce Grouse shooting land interests Champion / advocate (e.g. David Attenborough)

Land management – unknown impact on sediment volumes	Moorland management Hunting/shooting eststaes and their customers Stock and arable farmers NFM intervention deisgners Yorkshire Water Yorkshire Dales Rivers Trust – link with farmers, farm plans, farm guidance and NFM Fishing
Woodland – land use / management / proximity to river	RSPB Woodland Trust Forestry Commision Natural England Land managers Defra, policy makers Ecologists Local companies offsetting carbon emissions National Trust Landscape Parish Council Committees Beavers

8 Outputs and next steps

Aim: To capture agreement and commitments on actions that will be informed by the workshop to set the direction of the catchment plan.

Format: The facilitator asked the group to suggest actions and commitments and captured these on a white board. These are summarised below:

1. Define ambition and aims (and share)
2. Collate existing available data
3. Identify data gaps and what further data collection can feasibly be commissioned to address those gaps, for example a full sediment audit.
4. Define constraints on planned interventions and expected benefits
5. Build in legacy planning from the outset, e.g. how additional funds will be sought to maintain NFM assets, continue monitoring, keep data accessible, update analysis of performance
6. Give support to enable a research network to develop
7. Set and review the governance structure for the project
8. Engage landowners and managers, farmers, stakeholders
9. Set out a vision to be a “demonstration catchment”