Modelling Natural Flood management using SD-Topmodel

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The Upper Rother Catchment: Creating an evidence directory of natural flood management

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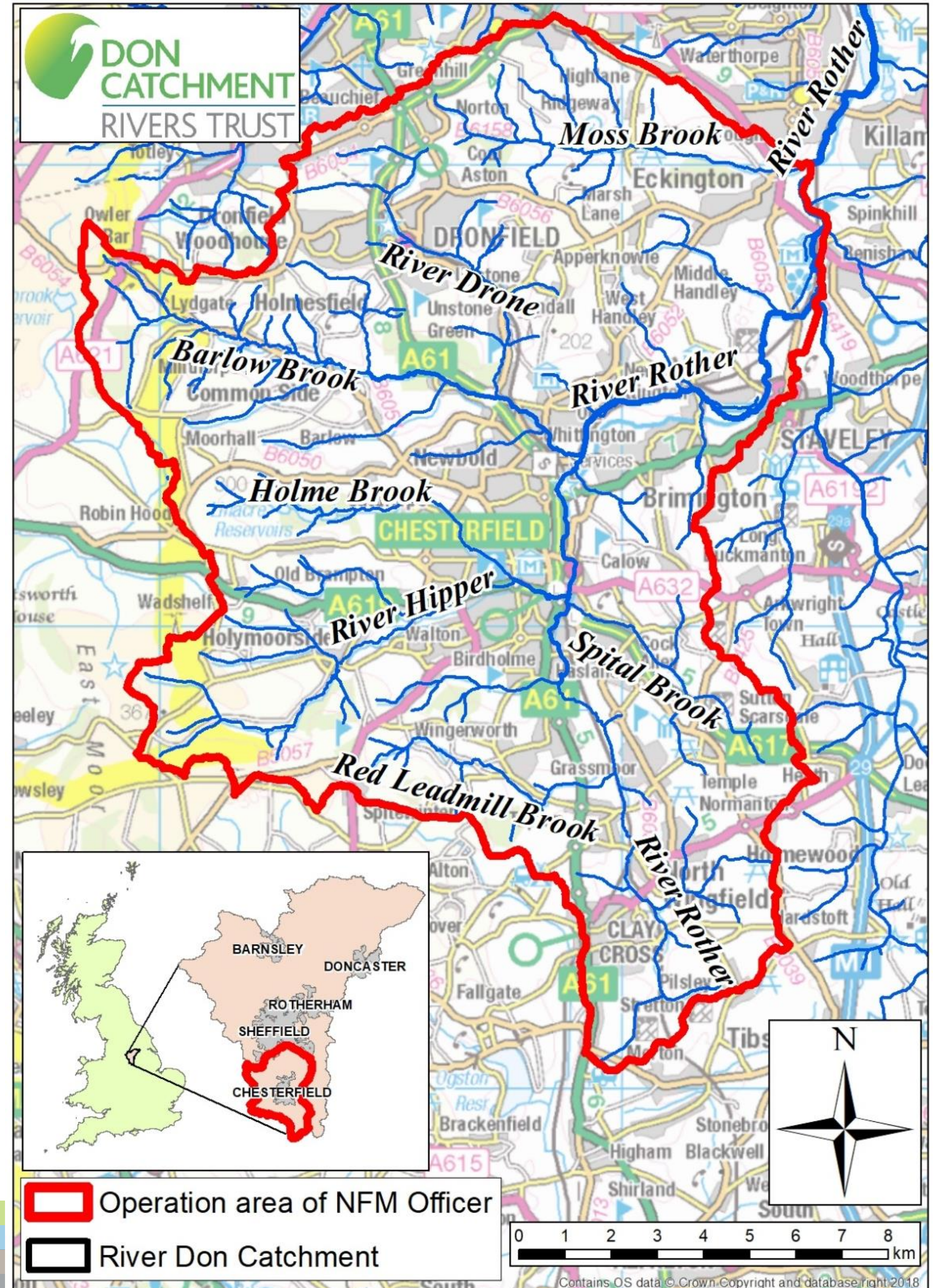
Natural Flood Management in the Upper Rother Catchment



Rother Farm Scheme

Grassmoor Country Park

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Moss Valley Woodlands

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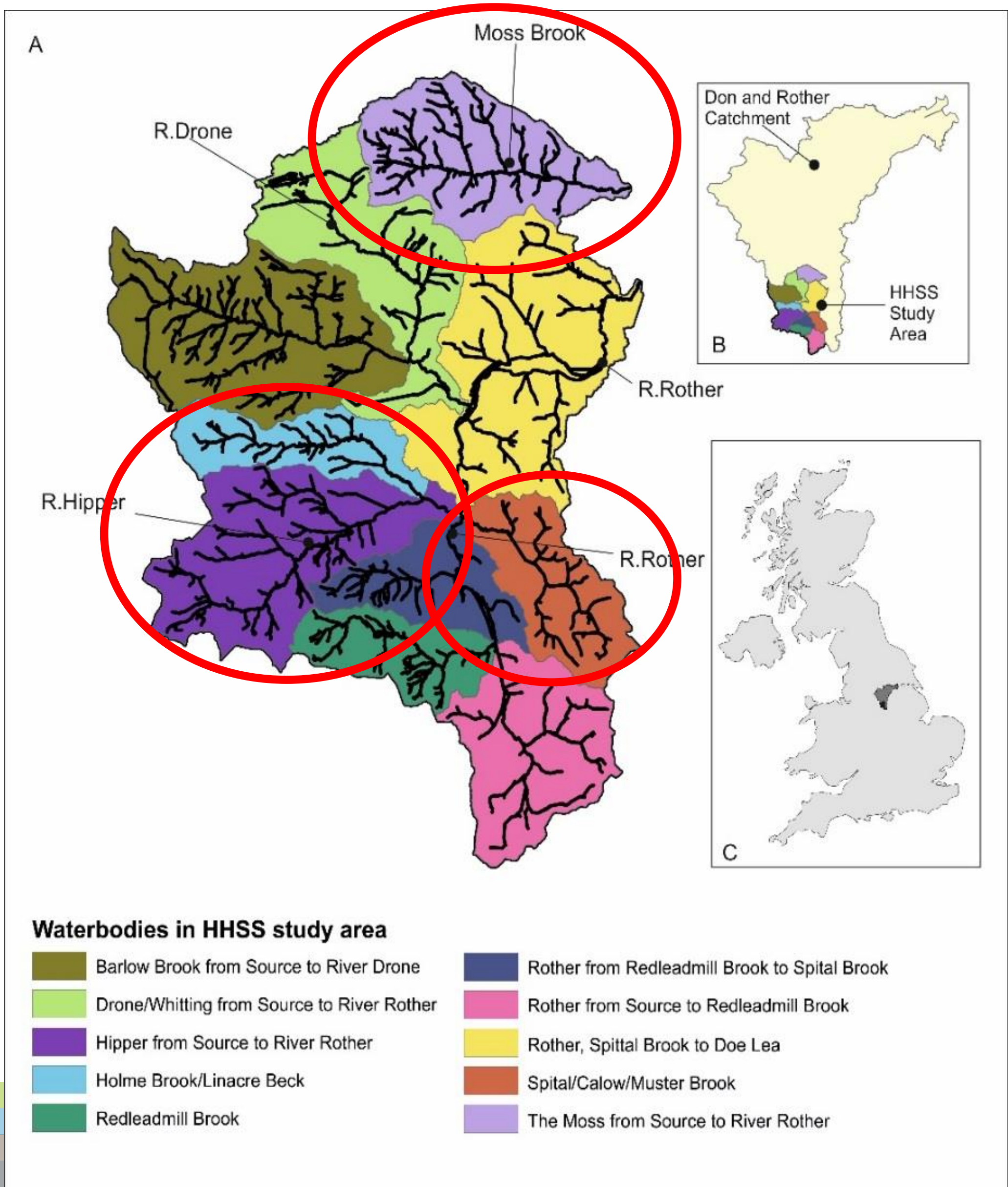
Upper Rother iCASP project

- Follow on to the iCASP Don Project that fed into one aim of the HHSS project
- Using **SD-TOPMODEL** to quantify reduction in flood peak, and time to peak.
- 3 sub-catchments: Moss Brook, River Hipper and Spital Brook.
- Aim to understand the types and scales of NFM interventions and quantify impacts to secure funding

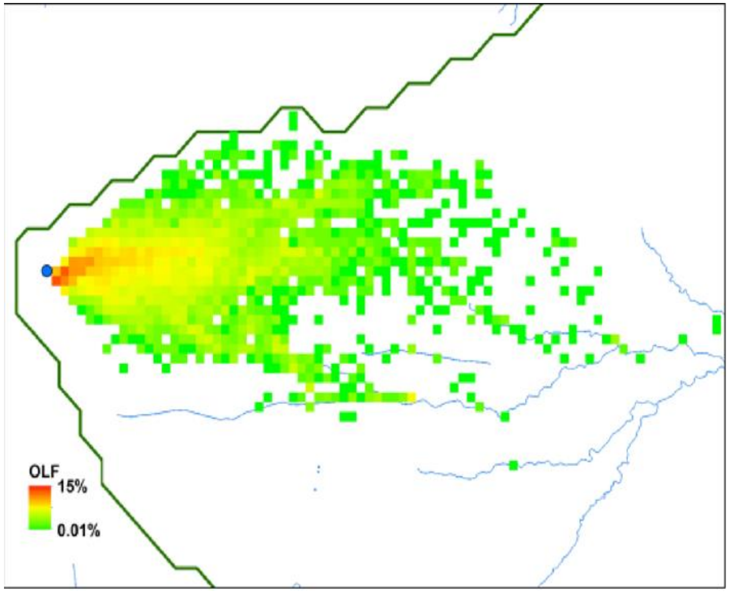


SD-TOPMODEL has 3 processes that require parameters

1. Rainfall falls onto a grid.
2. Rainfall is absorbed (the amount of rainfall absorbed in a cell is defined by M)
3. The rainfall that has been absorbed in a cell will move based on the conductivity (K)
4. Rainfall that is not absorbed is moved across the surface. The speed at which is can move is described by KV

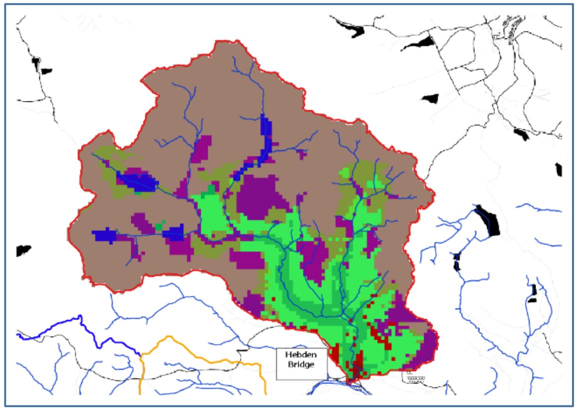
M - Soil depth parameter or *the depth of the bucket* (defines exponential decay of subsurface flow)
K - Soil conductivity or *the number of holes in the side of the bucket* (the conductivity of the subsurface layer)
Kv - Surface roughness parameter or *the smoothness of the top surface bucket* or *speed of water on the surface* (similar in principle to Manning's n)

SD-TOPMODEL

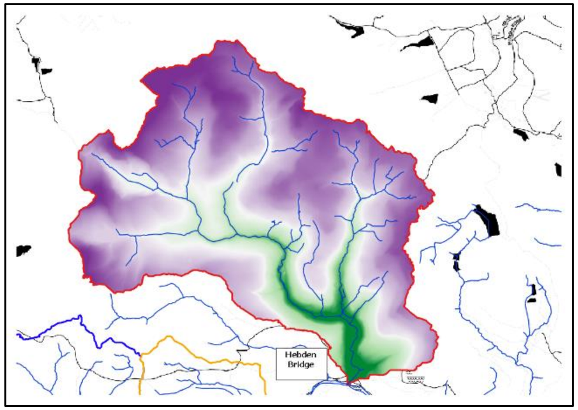


Parameter	Min	Max	Step (for part 1)
M	0.006	0.024	0.04
K	100	300	100
KV	10	50	10

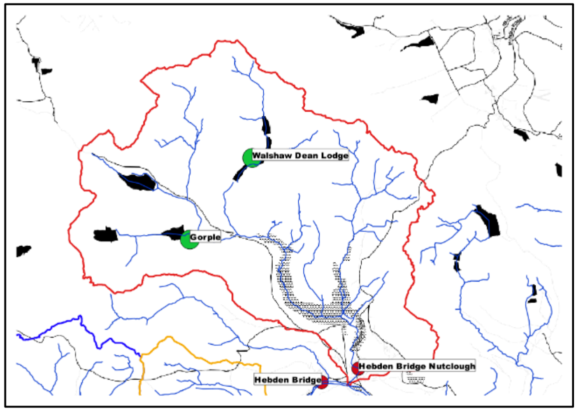
SD-TOPMODEL example



LandSAT derived landuse data

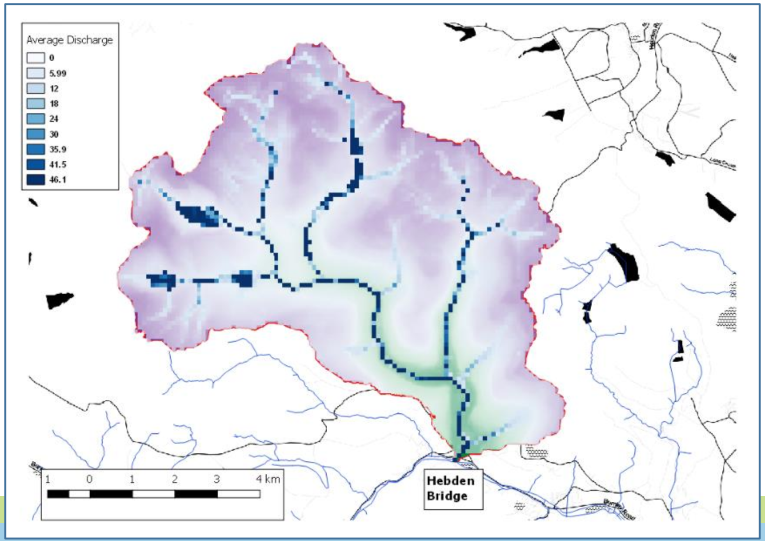


5m Terrain Data

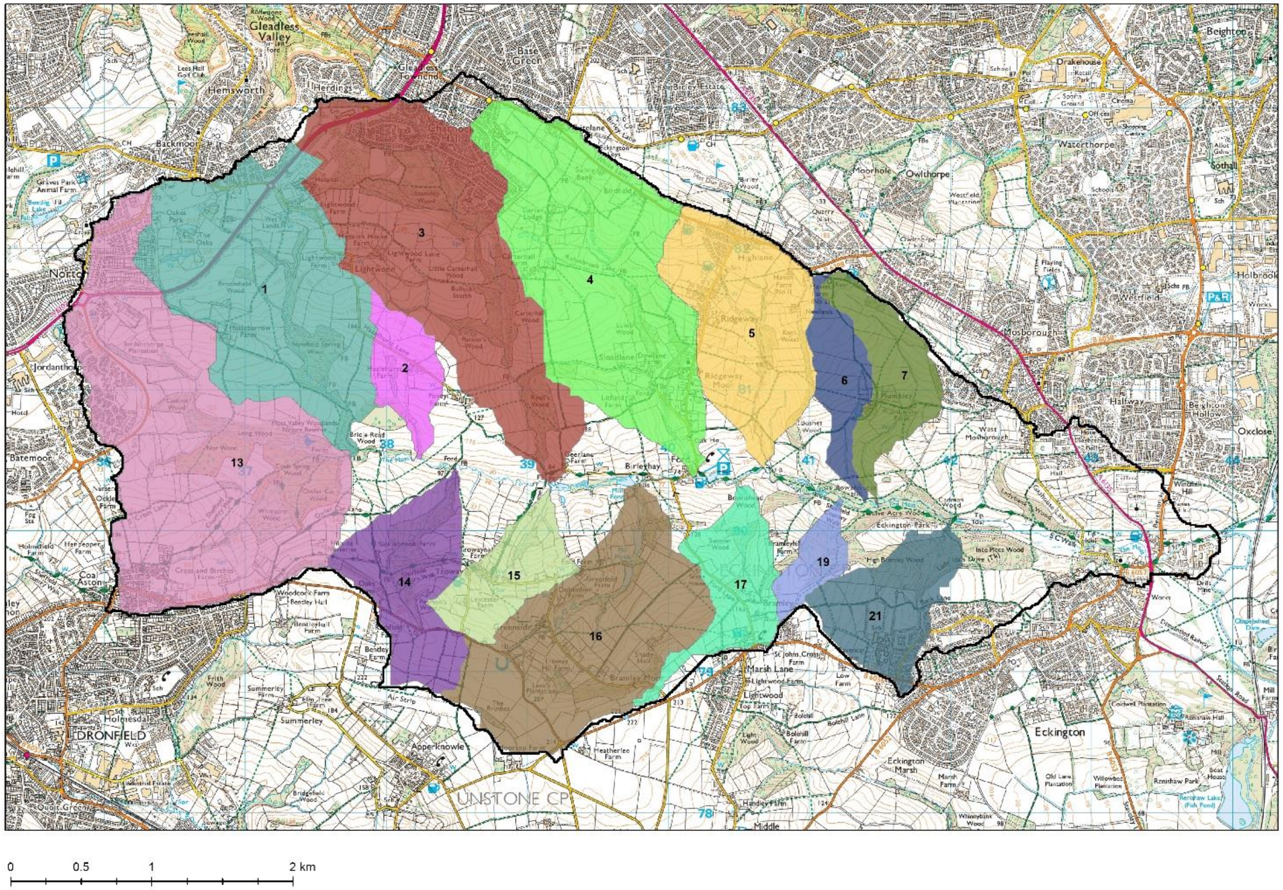


Rain and River gauge data

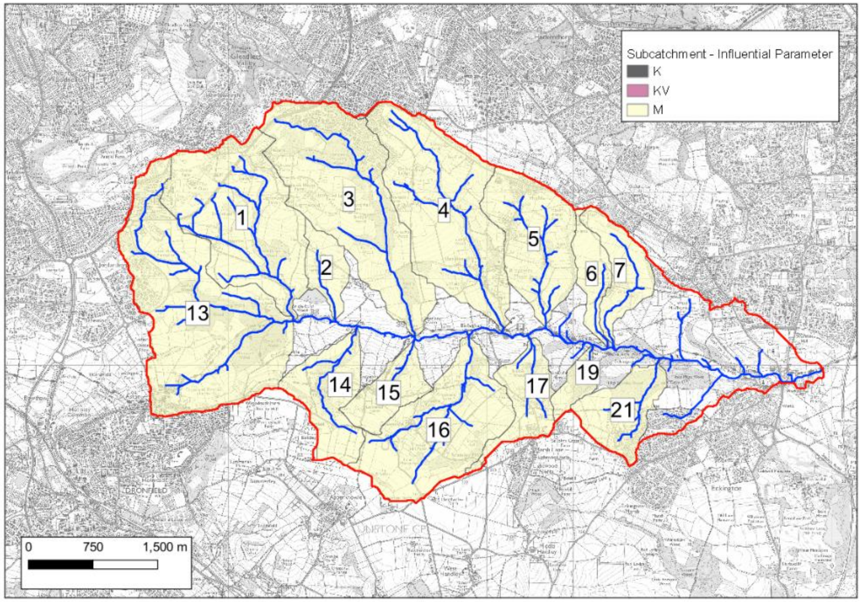
Or satellite derived land use maps

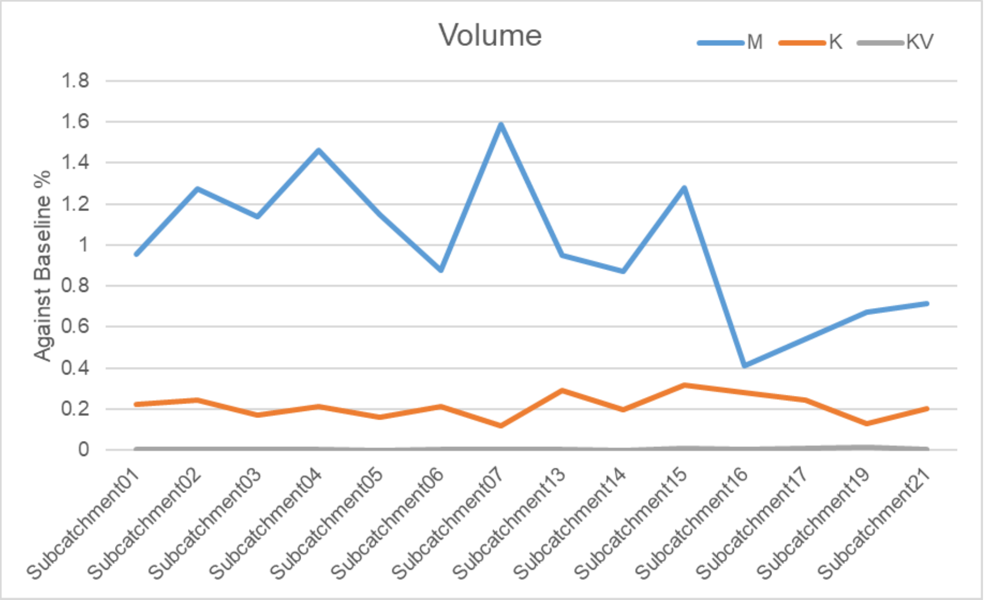


Modelling: Moss Brook



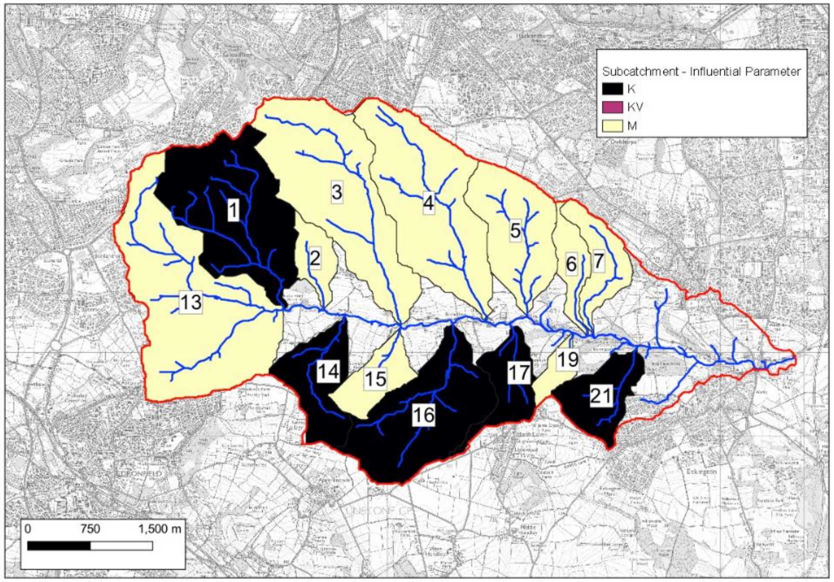
What impacts the volume of water?

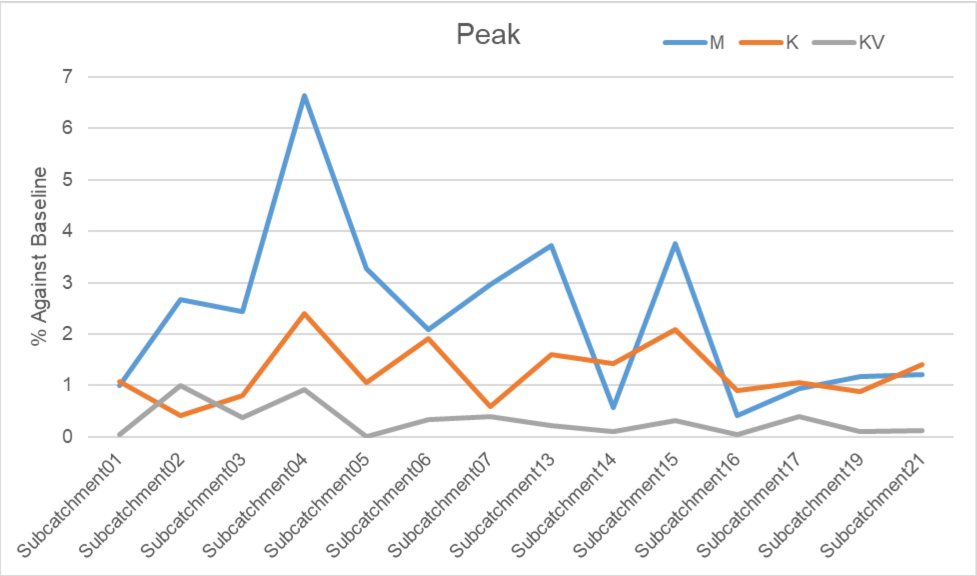




Volume – clear influence of soil depth (M)

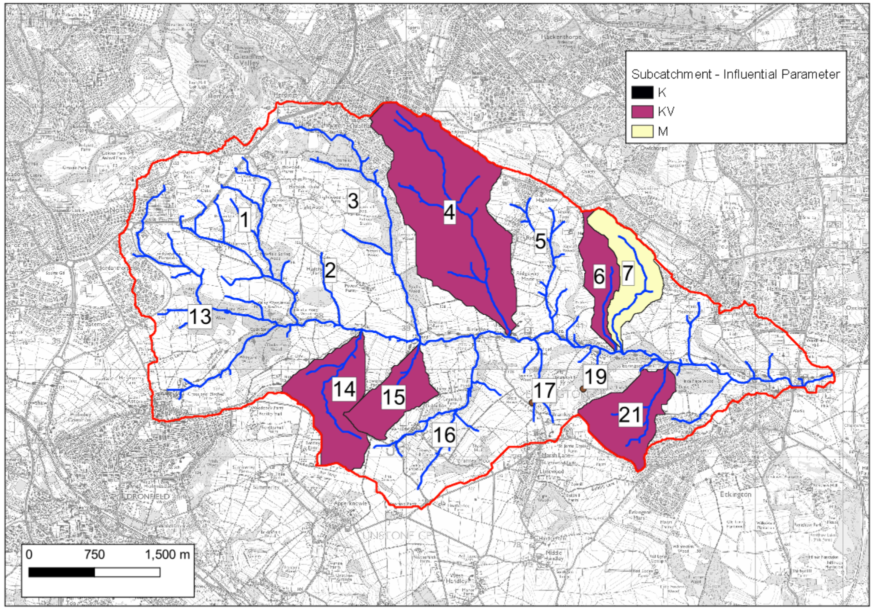
What impacts peak volume?

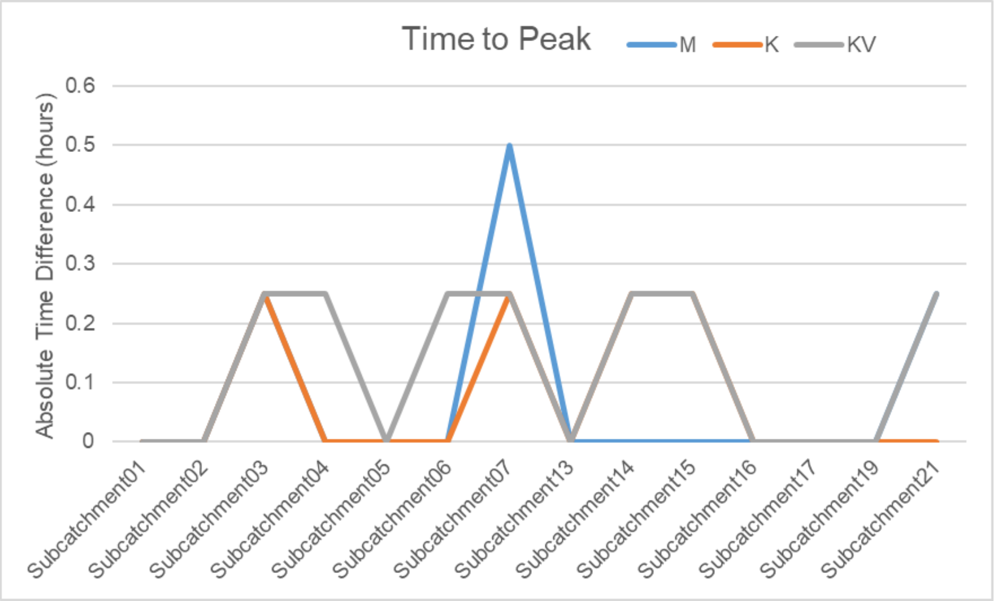




Peak Value – Again lower overall impact, soil depth (M) still very important, but soil conductivity (K) also significant

What impacts time to peak?





Time to Peak – Most sub-catchments have a negligible effect on the timing of the peak (less than 15mins)

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Application of Outputs

- Coordinated support for landowners
- Deliver NFM in areas that will have the greatest impact using the most effective methods
- Stakeholder workshops
- Monitoring
- Funding to support delivery
- Expand existing project work

YorkshireWater

Environment Agency

City of BRADFORD METROPOLITAN DISTRICT COUNCIL

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Backstone Beck Understanding the benefits of NFM

Dr Mark Trigg, Civil Engineering

Dr Thomas Willis, School of Geography

Kirsty Break-Holdsworth, Bradford City Council

Simon Stokes – Environment Agency

Tom Glazzard – Yorkshire Water

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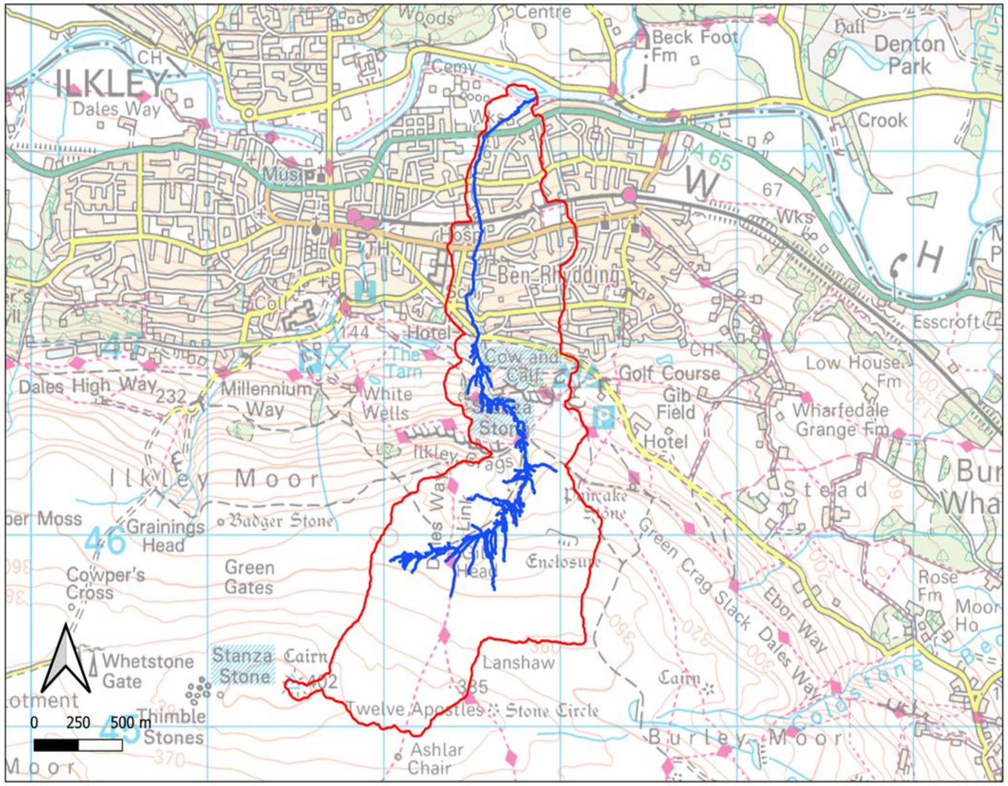
Backstone Beck – Project aims

This project has 2 modelling aims



• Identify how we can incorporate NFM features into hydrodynamic models

• Determine the impact of NFM interventions that have been implemented in the catchment and how they can help future management of the catchment

This work uses a 2D hydraulic model using a 'rain on grid' approach in the latest version of the hydraulic model HEC-RAS

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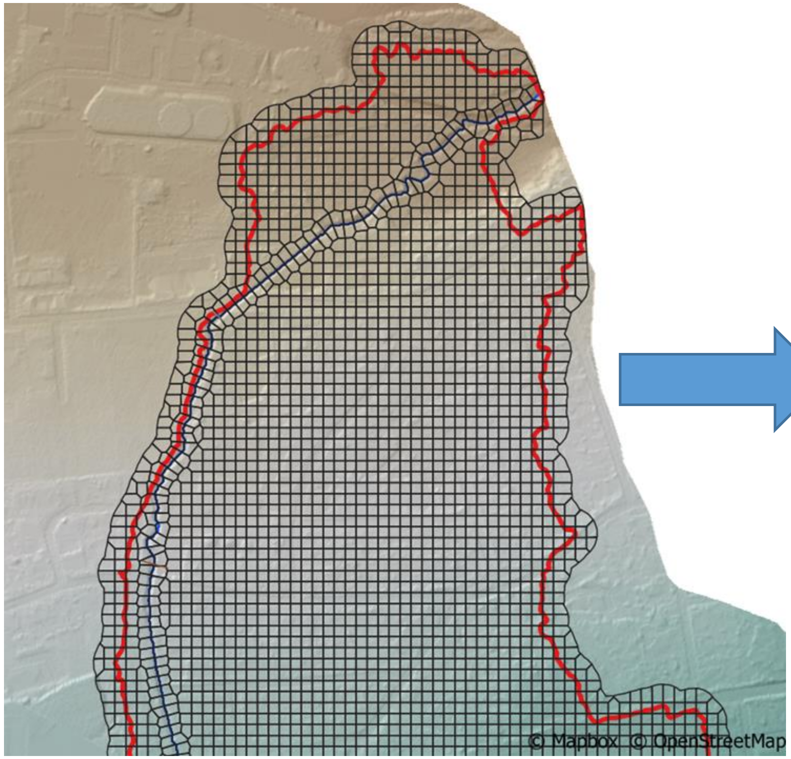
Backstone Beck – Project aims

- https://youtu.be/9u1-MHSXvsg

Backstone Beck – Building the model

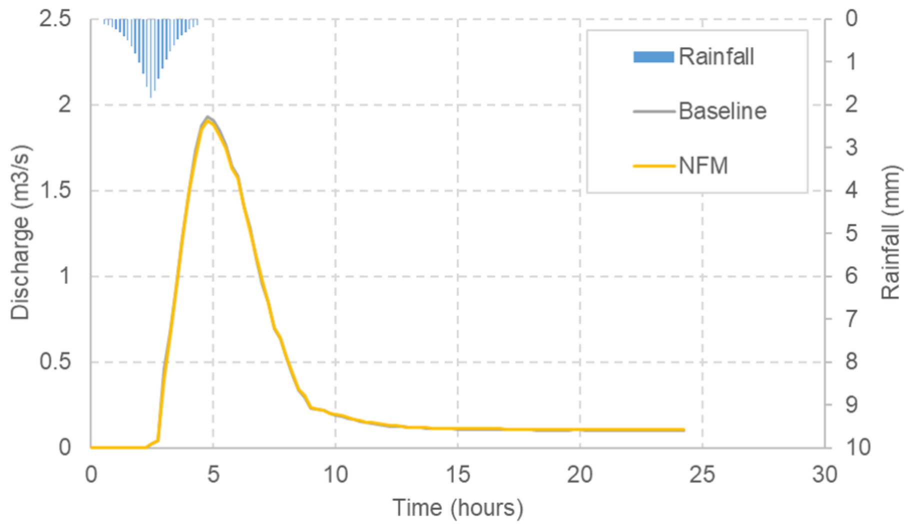


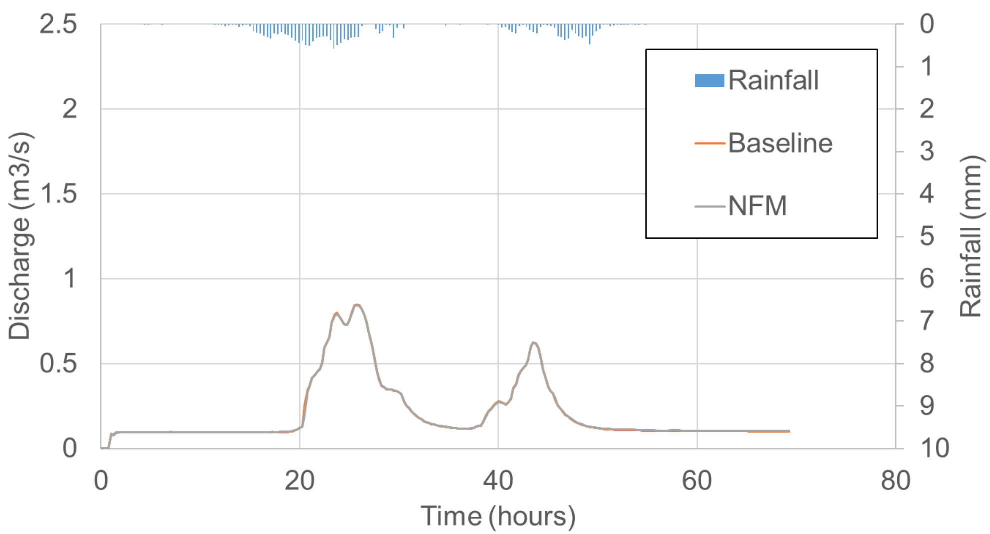
Gauge image – Kirsty Break-Holdsworth

Backstone Beck – NFM

Leaky dam images – Laura Snowden, LiDAR image Mark Trigg,
Fixed Camera image – Moors for the Future/BCC

Backstone Beck – Results





We tested the model against a range of observed events and ReFH events

The reduction in peak as a result of NFM is between 1 – 2%

Event	Baseline	NFM
6hr 10 year	1.93	1.90
6hr 50 year	2.50	2.46
Event 1 – Dec 2020	0.84	0.82
Event 3 – Jan 2021	0.56	0.55
Event 8 - August 2021	0.56	0.55

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Swinton Estate: quantifying impacts of tree planting

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Kate Tomlinson, Holly Story, GCS Grays

Charles Clark, Laura Angel, Mark Cunliffe-Lister
Swinton Estate

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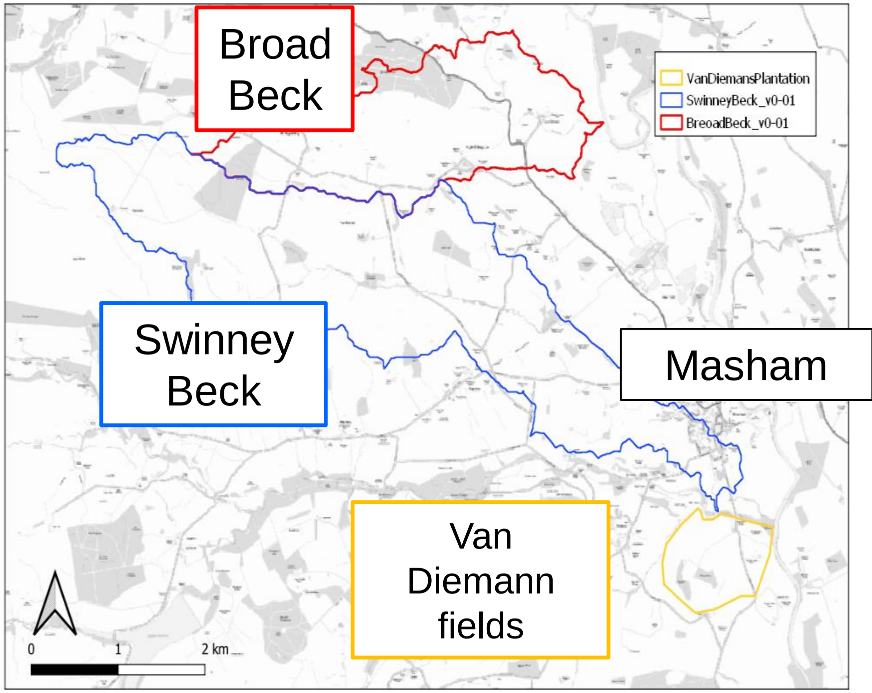
Swinton Estate

Funded by: Natural Environment Investment Readiness Fund

Create and manage new woodlands:
- 350ha in 20 years

Aims to:
- Generate revenue from forestry
- Reduce flood risk
- Increase carbon sequestration, biodiversity and water quality



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1. SCIMAP: Complete **‘hotspot analysis’ for soil erosion and flood risk**
2. SD-TOPMODEL: Deliver **detailed hydrological modelling** to quantify benefits of tree planting in specific areas

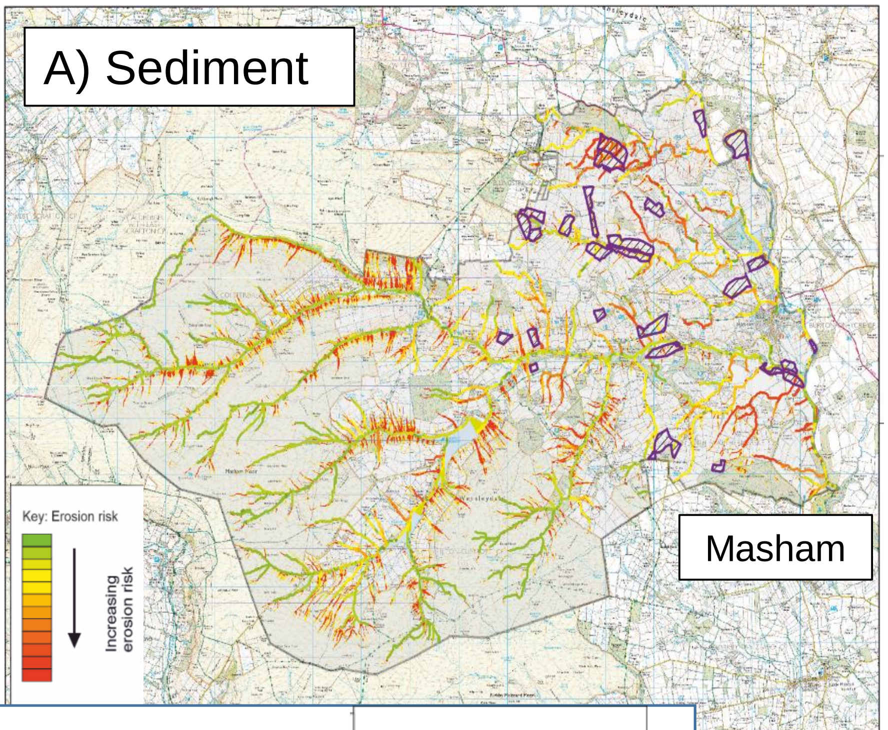
Swinton Estate: Stage 1 **SCIMAP (Whole estate)**

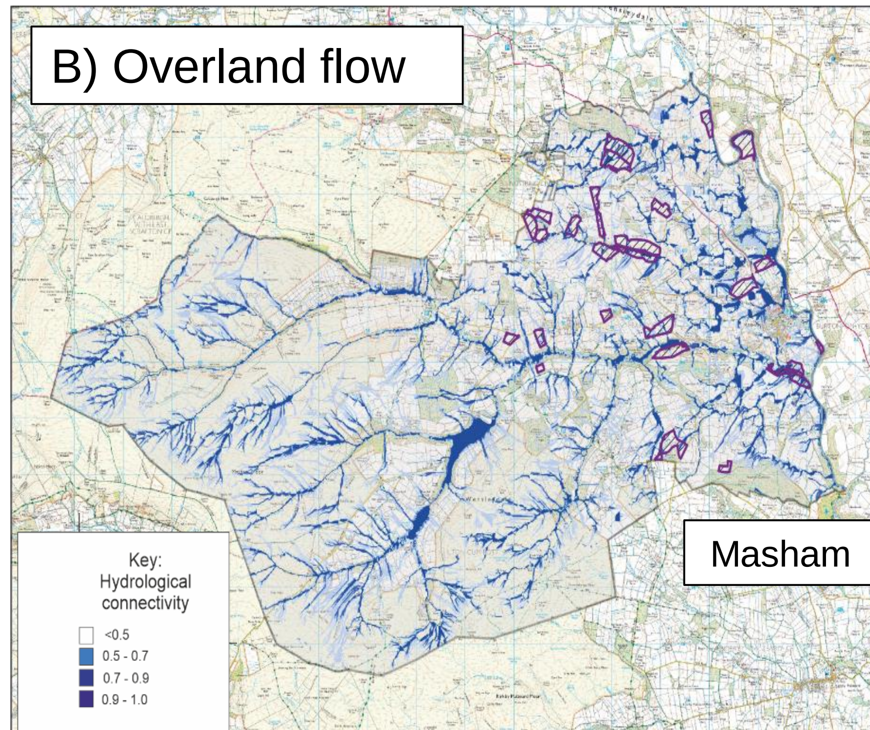
Determine:

A) Relative risk of fine-grained sediment movement across a catchment;

B) Where overland flow is likely to occur

Identified top 5 opportunity areas ready for stage 2….





This map is an output of SCIMAP, developed by Dr Sim Reaney at Durham University. SCIMAP maps the relative risk of erosion within a given catchment, it does not produce absolute volumes. SCIMAP is based of sediment availability (taken from land use maps) and sediment connectivity (based of the topography and rainfall, e.g., can the sediment reach the channel network?).

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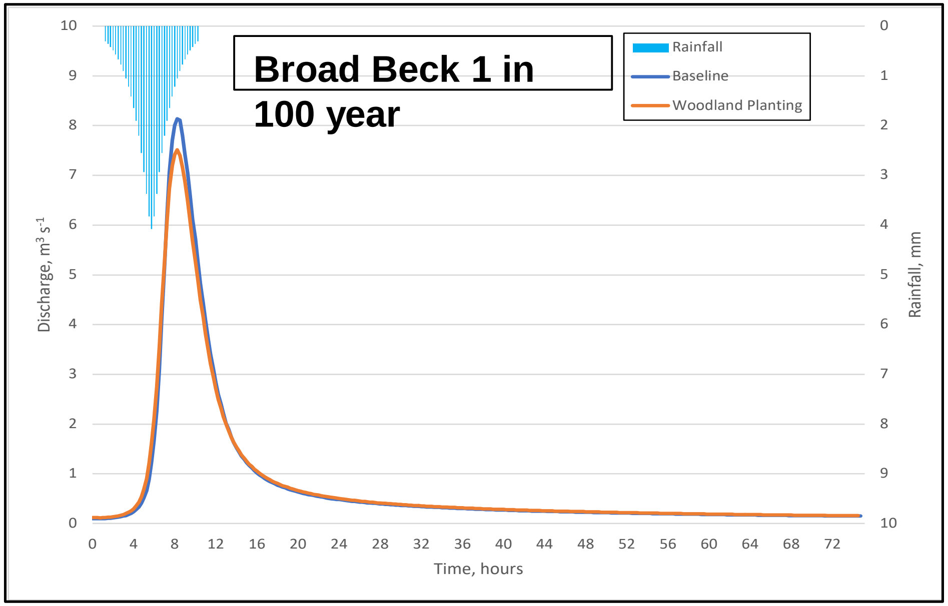
Swinton Estate: Stage 2

SD-TOPMODEL (Per sub-catchment)

Key Results

Woodland planting:

- Reduced flood peak by 1.2 to 8.6 %
- Change flood volume by -1.2 to +1.5 %
- Delayed peak timing by 15 to 30 minutes



Sub-catchment	Woodland type	% change in woodland cover from baseline	Difference from baseline (current catchment land cover)					
			Peak (%)		**Volume (%)**		**Time (minutes)**	
Storm event (1 in X year)			10	100	10	100	10	100
Broad Beck	Mid-catchment	+11.6	-8.6	-7.7	+1.5	-0.4	+30	+15
Swinney Beck	Riparian	+0.56	-1.2	-1.5	-0.3	+0.1	+15	+15
Van Diemann fields	Catchment outlet	+3.54	-3.3	-3.5	-1.1	-1.2	+30	+15

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Contact us through: iCASP@leeds.ac.uk

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Any questions?

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