

Case study 31. Hills to Levels Project

Authors: Sabine Peukert, Joanna Uglow, Ann Langdon, Ben Thorne, Louise Webb

Main drivers: Flood risk, water quality, community engagement, climate adaptation, habitat creation

Project stage: Ongoing



Photo1. Flooding to the Moors in 2013/14 closing the A372 (Source: Environment Agency Hills to Levels Multiple Benefits Business Case)

Project summary:

The Hills to Levels project aims to join up the communities in the upper and lower catchments in Somerset with the message that every field, every farm and every stream has a part to play in reducing flooding. Work is underway to 'slow the flow' of water from the hills to the levels. The Hills to Levels project (Map 1) works across a large catchment (2,871km²). Advice and capital grants are offered for measures that:

- improve infiltration into soils
- attenuate, divert, slow, filter and temporarily store run-off
- slow water in ditches and streams
- attenuate run-off and reconnect floodplains

Besides flood risk reduction, the advice and capital grants offered by the Hills to Levels project achieve in wider environmental benefits such as improving water quality and wildlife habitats.

The Hills to Levels approach first emerged from the land management workstream of the Somerset 20 Year Flood Action Plan following the winter 2013 to 2014 flooding. It has since developed improved measure design, increased the types of measures, and added further environmental aims and objectives.

Key facts:

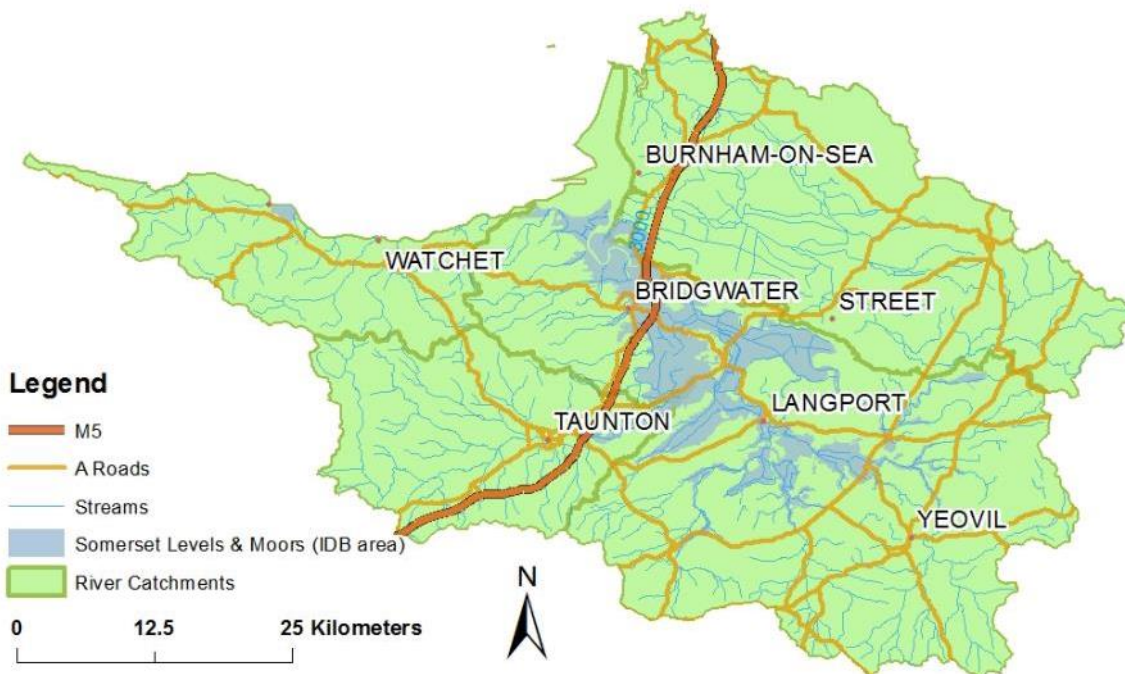
Evidence gathered to target/justify the work:

- Working on improving soil structure could make a large contribution to delaying and reducing flow peaks by increasing water infiltration. Deep, freely draining soils cover 30% (765km²) of the area and have the potential to accept 150–300mm rain in a 24-hour period (Palmer 2015).
- Soil husbandry advice tailored to soil type is important. In a wet year, the safe soil working period (the period in which the risk of causing soil compaction and degradation by trafficking is low) can be up to 6.5 weeks shorter in wet years.
- Modelling work suggests that attenuation features in the upper catchment can reduce peak flow by up to 10% (1 in 30 year event) in steep subcatchments, and up to 40% in flatter subcatchments.

Since the start of the project (summer 2015), Hills to Levels has delivered:

- 130 structures constructed Working with Natural Processes (WWNP)/Natural Flood Management (NF)M schemes, further 105 structures in progress and another 86 structures proposed
- WWNP/NFM advice visits to 159 farms or and holdings
- 7 WWNP/NFM videos to visualise individual measures that have been employed so far – more videos to come (<https://www.youtube.com/channel/UCQzUFXhjlwqsahY4JGQgkWw>)
- a series of technical information sheets to provide guidance to farmers, land managers and contractors

The project has achieved so much because it combines a range of different funding sources and works in partnership with other organisations such as Catchment Sensitive Farming, local councils and the Somerset Rivers Authority. It delivers multiple benefits in addition to WWNP/NFM (water quality, wildlife habitats), ties in WWNP/NFM funding with Countryside Stewardship to make it more attractive for farmers/landowners to be involved, and has the support of a technical advisory group of specialists in the Environment Agency.



Map 1: Hills to Levels catchment

1. Contact details

Contact details	
Names:	Sabine Peukert, Joanna Uglow, Ann Langdon, Ben Thorne and Louise Webb
Lead organisations:	
Partners:	Natural England, Catchment Sensitive Farming, Environment Agency, Royal Bath and West Society, Somerset Wildlife Trust, RSPB, Somerset Rivers Authority
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2. Location and catchment description

Catchment summary	
National Grid Reference:	ST228230
Town, County, Country:	South and West Somerset catchments
Regional Flood and Coastal Committee (RFCC) region:	Wessex
Catchment name(s) and size (km²):	Parrett, Tone, Brue, Axe and West Somerset Streams: total size 2,871km ²
River name(s) and typology:	Lowland rivers
Water Framework Directive water body reference:	Multiple
Land use, soil type, geology, mean annual rainfall:	The large project area covers a wide range of land use (arable and grassland), soil types, and geology and mean annual rainfall.

3. Background summary of the catchment

Socioeconomic/historic context

Somerset is predominantly a rural area, with farming employing around 10,000 residents and bringing in around £200 million per year. The soils within the catchment are extremely varied and, although traditionally a dairying county, enterprises now include intensive arable cropping, including roots, through to extensive beef and sheep on the poorer soils and in the wetter areas.

On the Somerset Levels and Moors, rivers have been modified and embanked, and water levels and flow manipulated with sluices and pumps, to produce the lowland wet grassland and 'wet' fencing typical of this landscape. The area is one of the largest wetlands in Britain and home to wildlife of national and international importance. The free flowing tidal reaches bring silt upriver from the Severn Estuary. The area has a high wildlife value and is designated at international levels. Agriculture is the dominant land use, mainly arable, dairy and beef. The countryside and coastline is important

economically for tourism and recreation.

The Somerset Levels and Moors have always had seasonal flooding and most farming systems on the Levels can cope with several weeks of winter flooding. However, in recent years, river levels are rising faster after rainfall events and, with climate change, the number and volume of these events is likely to increase.

As well as flooding on the levels, there has been an increase in the number of houses and roads being affected by flooding. The closure of roads during the flooding of the Somerset Moors and Levels between 2012 and 2014 is estimated to have cost local businesses in the region of £100 million.

Flood risk problem(s)

Flood risk problems occur in the lower catchments as well as localised either fluvial or run-off flooding in the upper catchment.

Flood risk in the catchments draining to the Somerset Levels and Moors are described in the Catchment Flood Management Plans for the 2 relevant catchments.

Parrett Catchment Flood Management Plan

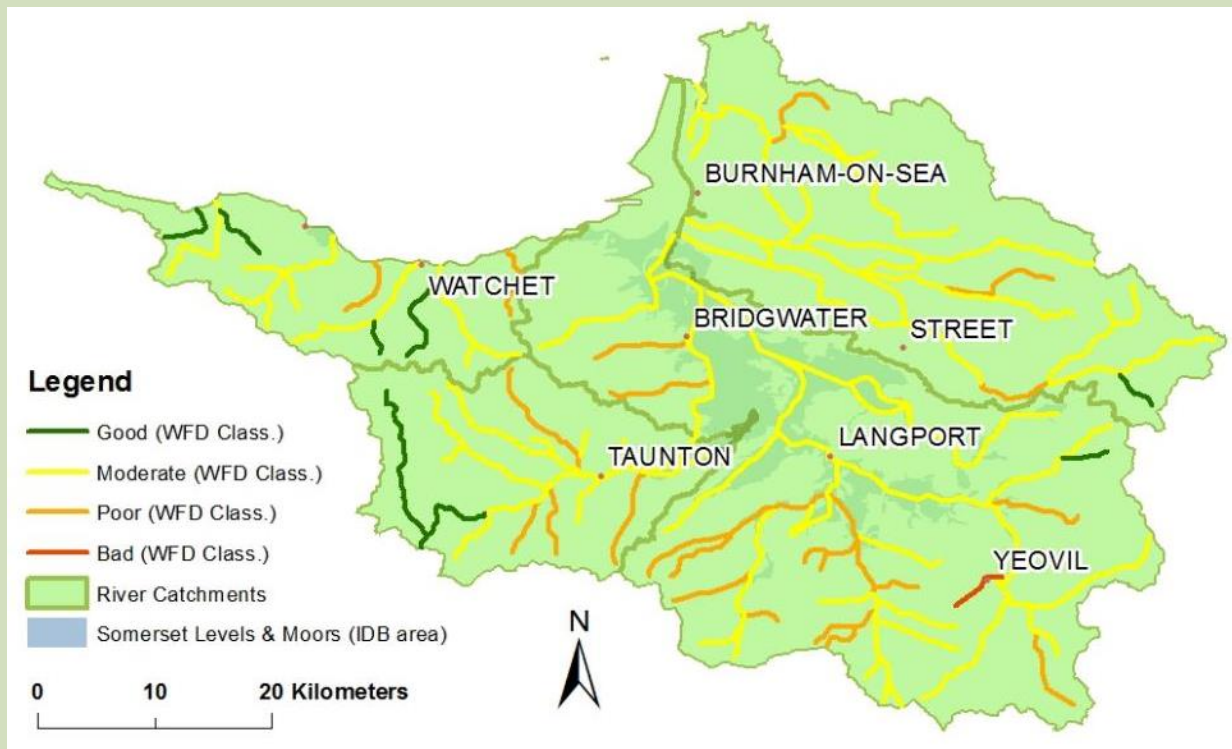
'The major rivers start in the steep uplands, then flow through flat lower moors, where they are embanked and in some places perched above the surrounding floodplain. The lower reaches of the rivers Tone and Parrett are tidal for some 30km (18.6 miles) from the Severn Estuary. The steepness of the uplands, coupled with the geology and soil conditions, generates quick run-off from short intense rainfall. In the Somerset Levels and Moors, flooding is caused by longer duration storms or a series of storms of low intensity. The high level embanked channels overflow and floodwater is stored in the moors before it can reach the estuary. The capacity of these channels can be significantly reduced by high tidal conditions backing up the Parrett. Internal Drainage Boards have an important role in managing land drainage within these low-lying moors. The underlying rock has a significant influence on the catchment's response to rainfall, with high run-off from the impermeable uplands in the east and waterlogging of the lowlands. The area does not have any major aquifers so groundwater flooding is not a major risk.'

West Somerset Streams Parrett Catchment Flood Management Plan

'The rivers and streams flow from their sources on Exmoor and the Quantock Hills, in the south and east of the catchment respectively. They are steep in nature and flow towards the Bristol Channel in the north. Geology has a significant influence on the response to rainfall. The geology of West Somerset has low permeability, this contributes to the high level of overland flow and the rapid response of the rivers to rainfall. The West Somerset Streams have a long history of flooding. Currently the main sources of flood risk for people, property, infrastructure and the land are flooding from rivers, tidal flooding in Minehead, Porlock and Blue Anchor, and surface water drainage flooding.'

Other environmental problems

Watercourses in the Hills to Level catchments suffer from water quality problems (Map 2). Less than 10% of catchments meet good ecological status and 22% are classified as poor ecological status. Rivers have been modified over time with impacts on ecology.



Map 2: Water Framework classification in the Hills to Levels catchments

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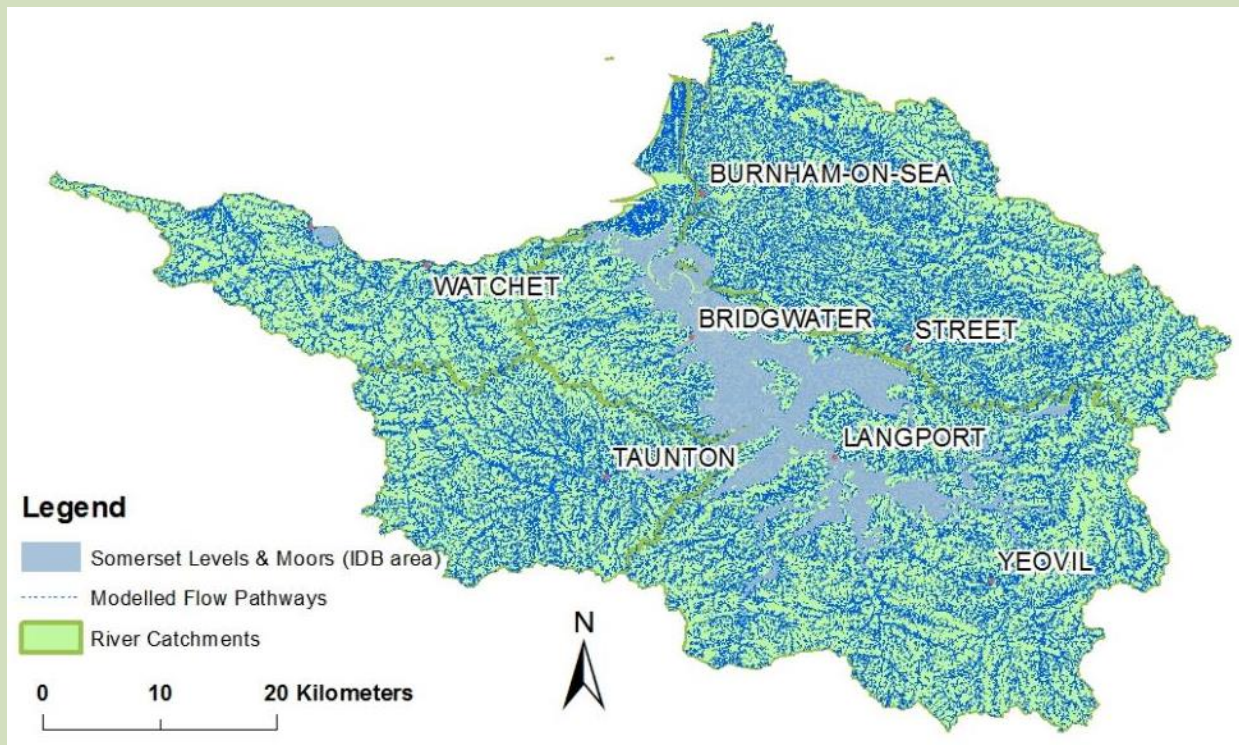
4. Defining the problem(s) and developing the solution

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

An initial scoping exercise using geographical information systems (GIS) modelled surface water flow pathways (run-off) across the Hills to Levels catchments (Map 3). Walkovers were then conducted to:

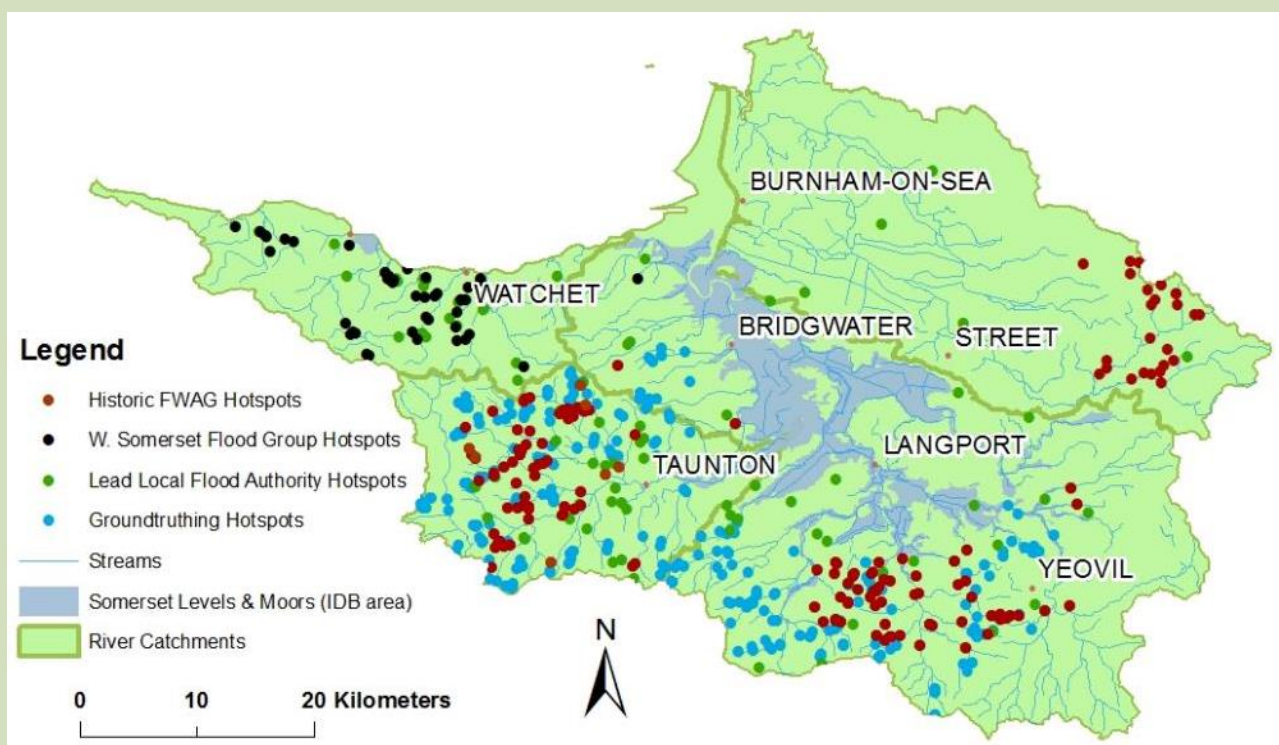
- groundtruth the modelled data
- identify flood hotspots (Map 4) and potential sites for structures

These hotspots were then added to a catchment-wide database, which also included historic data from partner organisations such as Lead Local Flood Authority as well as County Highways hotspots. This database is now used when identifying areas for WWNP and designing schemes. The modelled flow pathways often are a good starting point when discussing water, flooding and WWNP on farms. Additionally, an assessment of soil water storage capacity (Map 5) was commissioned for part of the project area, which created a soils GIS geodatabase that provides specialist information on soil associations and their hydrological characteristics, their susceptibility to different types of degradation and potential for natural regeneration.



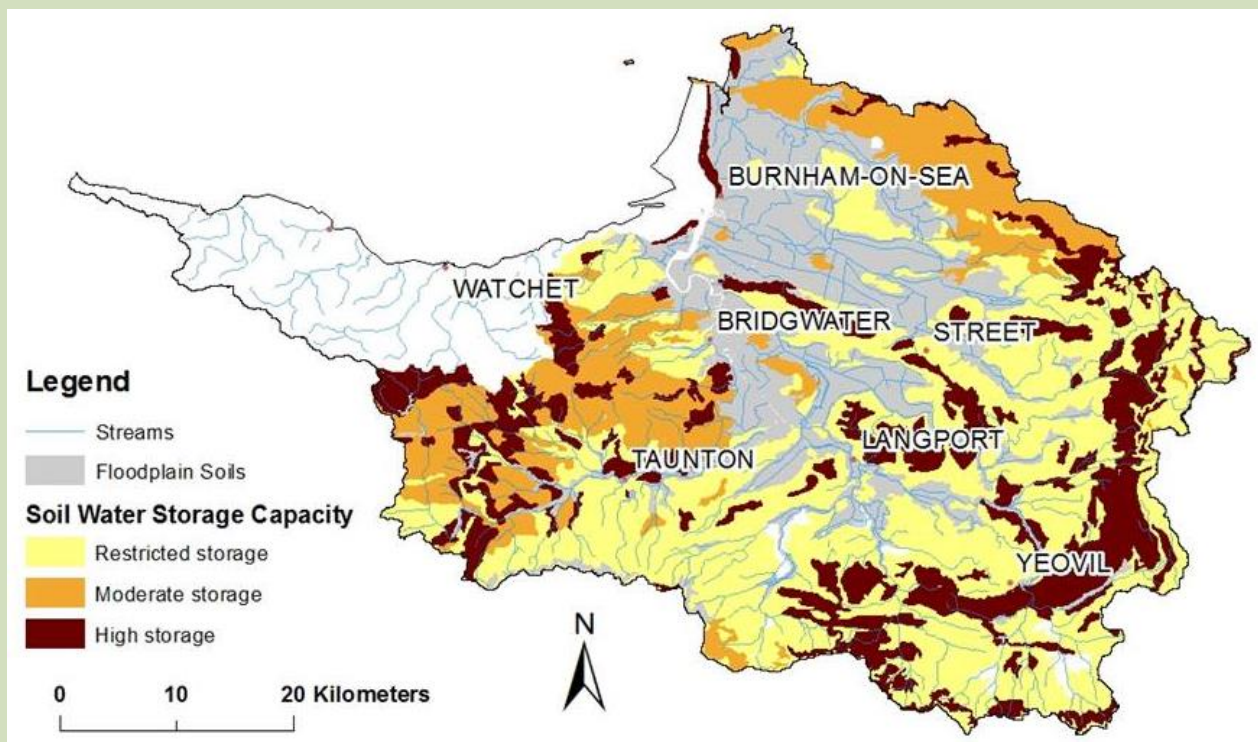
Map 3: Modelled flow pathways

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Map 4: Database of hotspots to use for targeting interventions

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Map 5: Soil water storage capacity when in good structural condition – sites with the greatest soil water storage capacity are targeted for soil husbandry visits

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What was the design rationale?

Project's design rationale

Flooding issues in Somerset have previously been considered as a problem in the lower catchment and flood risk reduction measures were mainly placed in there. The devastating winter floods of 2013 to 2014 launched a partnership of local and national organisations, co-ordinated by Somerset County Council, which developed the 20-year Flood Action Plan. This plan recognised that, alongside dredging, river management, the management of urban run-off and increasing resilience in local communities and infrastructure, reducing run-off and sediment delivery from the upper and mid catchment has a benefit on flooding in the lowlands (and a benefit on localised flooding in the upper and mid catchments). The Hills to Levels project was set up to deliver the land management aspect of the 20-year Flood Action Plan.

WWNP/NFM design rationale

A toolbox of NFM techniques is used to find solutions that are appropriate to the site, flooding situation, land use and the farming business. For example, leaky woody dams are often constructed in wooded valleys of the upper catchments. In the middle of the upper catchments, structures to intercept run-off onto highways are common, and lower down attenuation areas have been created adjacent to streams to reconnect floodplains and increase floodwater storage. Although there are some requirements that must always be met, the design of each scheme often varies, sometimes with input from the farmer or contractor involved. Since summer 2015, the following number and type of structures have been constructed:

- over 20 run-off interception features
- 14 large water attenuation features
- ~120 leaky dams

Many more of these types of structures will be constructed within the next year.

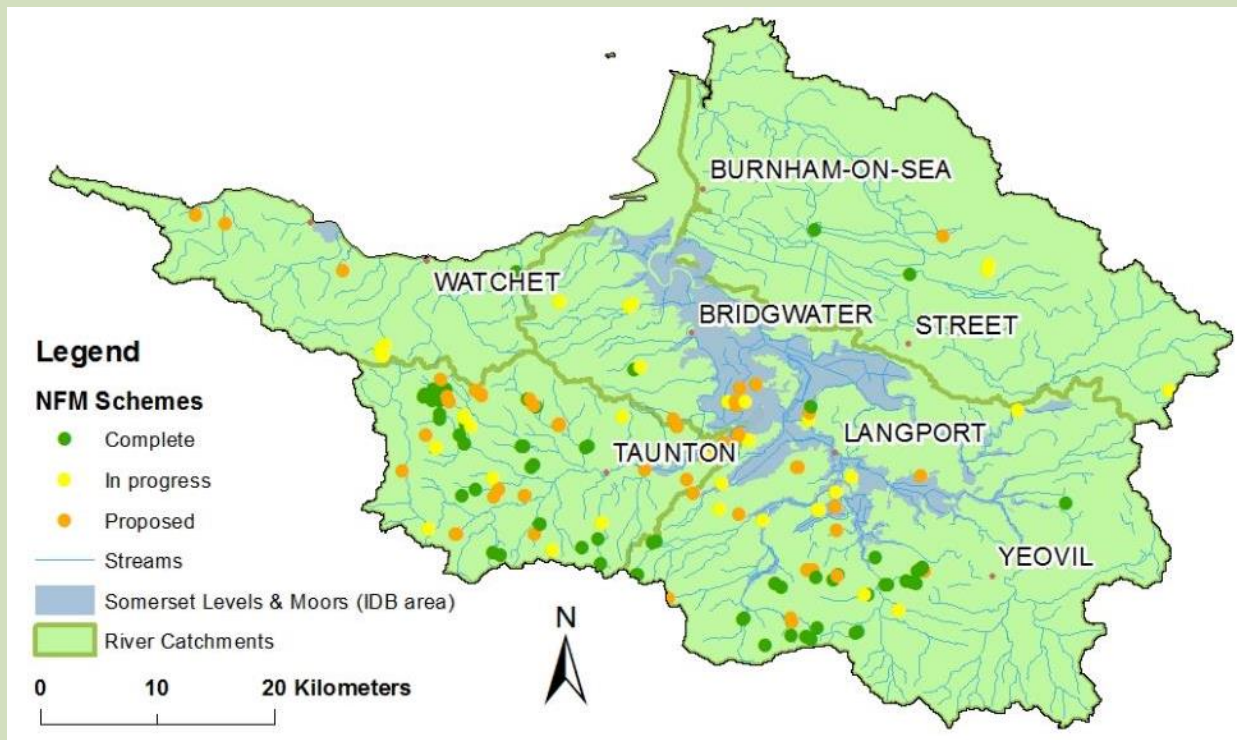
Project summary	
Area of catchment (km²) or length of river benefitting from the project:	2,871km ²
Types of measures/interventions used (WWNP and traditional):	Improved soil and land management (soil degradation assessments, 1:1 soil husbandry and crop rotation advice), run-off interception and diversion (filter socks, coir products, filter fence, soil bunds and swales, banked hedges, silt traps), water attenuation (floodplain storage, soil bunds, leaky ponds), slow the flow in-stream (leaky woody dams, brash dams, leaky barriers in ditches)
Numbers of measures/interventions used (WWNP and traditional):	Since summer 2015: <ul style="list-style-type: none"> • 130 structures complete • 105 structures in progress • 86 structures proposed
Standard of protection for project as a whole:	All measures delivered under the Hills to Levels project are WWNP measures. However, Hills to Levels only delivers a small aspect of the 20-year Flood Action Plan. Other work streams include urban run-off, dredging and river management, infrastructure resilience and building local (community) resilience.
Estimated number of properties protected:	Numerous properties in the upper catchment that suffer from surface water flooding and contribution towards protection of 150 properties in and around the Somerset Levels

How effective has the project been?

Approximately 15,000m³ of floodwater storage has been created in water attenuation features alone. Monitoring of individual measures within the catchments will take place in future (see monitoring section)

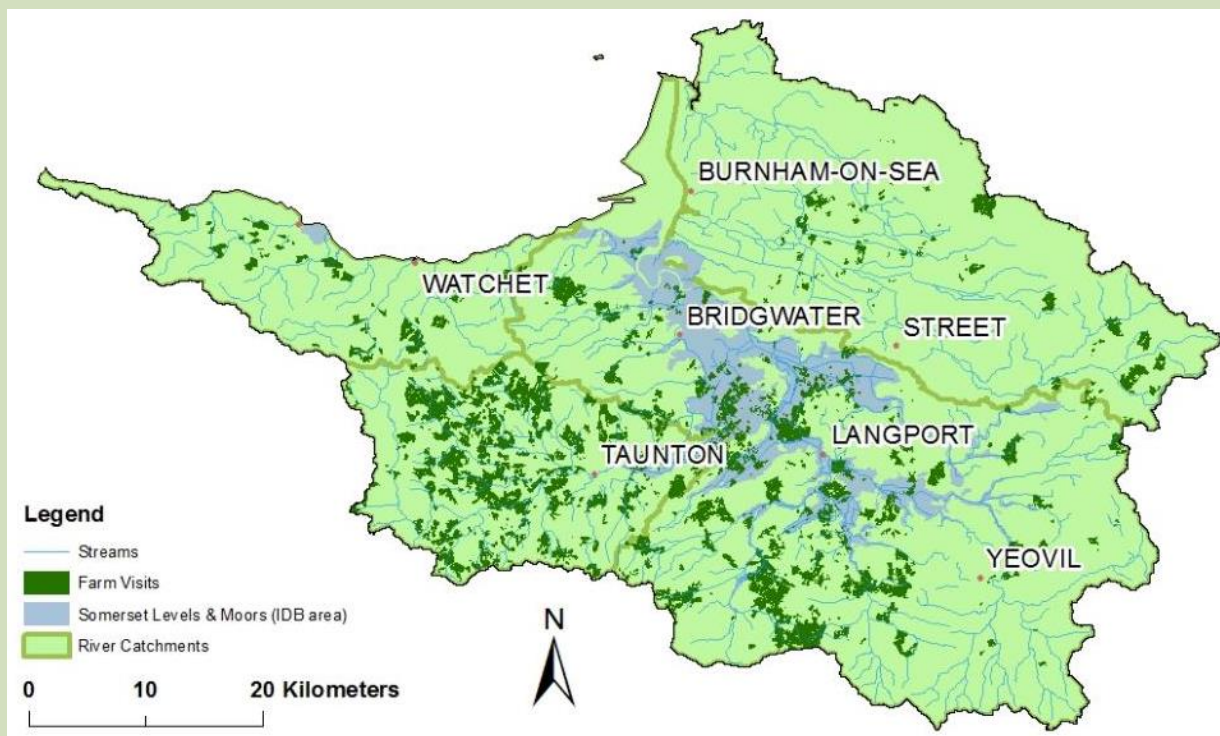
Since the start of the project (summer 2015), Hills to Levels has delivered:

- 130 constructed WWNP/NFM structures, a further 105 structures in progress, and another 85 structures proposed (Map 6)
- WWNP/NFM advice visits to 159 farms or land holdings (Map 7)
- 7 WWNP/NFM videos to visualise individual measures that have been employed so far – more videos to come (<https://www.youtube.com/channel/UCQzUFXhjlwqsahY4JGQgkWw>)
- a series of technical information sheets to provide guidance to farmers, land managers and contractors



Map 6: NFM schemes complete, in progress and proposed under the Hills to Levels project

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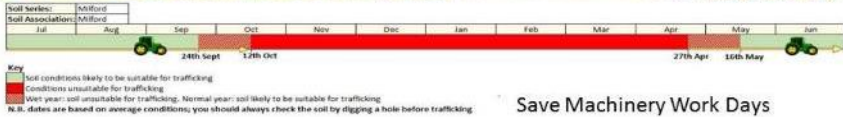


Map 7: Locations of farms that have received advisory visits under Hills to Levels so far

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The series of photos below show examples of completed Hills to Levels work.

Example 1: Improving soil structure and infiltration



Example 2: Slowing and Filtering Runoff



Example 3: Soil Bund





Photo 1: Examples of completed Hills to Levels work

5. Project construction

How were individual measures constructed?

The NFM structures are constructed using natural materials where possible. For example site-won soil is used, if suitable, to create banks and bunds for water attenuation areas, and trees felled adjacent to streams are used to construct leaky woody dams. Exceptions to these rules include some of the run-off interception features such as coir rolls, which are made from coconut husks; vegetation grows through and on this material which creates a feature that remains even when the original coir roll has biodegraded.

It is important to give the farmers/landowners ownership of the measures on their land. The farmers/landowners are given the choice of whether to do the work themselves where possible or whether to use contractors. The Hills to Levels team provides suggestions of local contractors, but the farmer/landowner can choose which contractor to use.

How long were measures designed to last?

The longevity of NFM structures varies widely, depending on the type of structure and the materials used. Ongoing maintenance of some structures is also essential to increase the life span. This might include de-silting of water attenuation areas or adding logs to woody dams as they rot over time. The grant funding contract specifies that structures must be maintained for 5 years, but structures are built to last beyond 5 years. Where possible, further funding such as Countryside Stewardship funding is accessed.

Since the project is contributing to the Somerset 20-year Flood Action Plan, it is hoped to continue efforts towards reducing flood risk using WWNP/NFM measures in the long term. There is potential that, within this timescale, NFM could be part of on-farm annual work and maintenance. If so, this could make a significant contribution to reducing flood risk, especially at localised hotspots.

Were there any landowner or legal requirements which needed consideration?

Consent from the Environment Agency (main rivers) and/or the Lead Local Flood Authority (ordinary watercourses) is required in a number of situations. In addition, planning permission is either required or prior notification should be given. In some cases, land was in a Countryside Stewardship agreement or designated as a Site of Special Scientific Interest (SSSI) and needed Natural England consent.

Negotiation with landowners is often required as, in many cases, they may lose subsidies (Basic Payments) for areas used. Sometimes issues may arise where profitable land will be lost but in many cases landowners are willing to take water if it will help the local community. Future maintenance should also be considered and those receiving grant funding under this project are required to sign an agreement stating that they are responsible for maintenance of the NFM structures for 5 years. At this stage, Hills to Levels can only fund advice and capital items, but not ongoing maintenance and management.

6. Funding

Funding summary for Working with Natural Processes (WWNP)/Natural Flood Management (NFM) measures

Year project was undertaken/completed:	<p>The Hills to Levels project started in spring/summer 2015 and is delivering part of the Somerset 20-year Flood Action Plan. The intention is to keep Hills to Levels running over at least the 20-year duration of the Flood Action Plan.</p> <p>Hills to Levels started as an individual project to deliver the land management aspect of the 20-year Flood Action Plan, which was set up in response to the flooding of the Somerset Levels and Moors in winter 2013 to 2014. It was originally set up in spring 2015 as a partnership project between the Farming and Wildlife Advisory Group (FWAG) South West, the Royal Bath and West Society, the RSPB and the Somerset Wildlife Trust. Since the original project, Hills to Levels has evolved into an umbrella approach that includes a range of sub-projects and funding streams.</p>
How was the project funded:	<p>The project was originally funded by the People's Postcode Lottery with match funding from the Heart of the South West Local Growth Deal Funding (Local Enterprise Partnership). Over time, individual aspects of Hills to Levels have been/are funded by a range of different funders: Environment Agency Catchment Partnership Action Fund, Environment Agency Environment Programme, Interreg (2 Seas)</p>
Total cash cost of project (£):	<p>£1.25 million including farm resilience work in the Somerset Levels as well as NFM work in the upper catchment areas</p>
Overall cost and cost breakdown for WWNP/NFM measures (£):	<p>Costs of NFM measures so far £375,000</p>
WWNP/NFM costs as a % of overall	<p>50% of project applies to NFM – the rest to soil husbandry,</p>

project costs:	farm resilience in the floodplain and innovative approaches
Unit breakdown of costs for WWNP/NFM measures:	Average costs for capital items (excludes adviser time): <ul style="list-style-type: none"> leaky woody dams: £250 per dam other NFM structures: £3,000
Cost–benefit ratio (and timescale in years over which it has been estimated):	Not yet determined



7. Wider benefits

What wider benefits has the project achieved?

When designing WWNP/NFM structures or advising landowners, wider environmental benefits are always considered. Most structures deliver multiple benefits, such as reducing water quantity and slowing the flow as well as improving water quality and creating wildlife habitats.

- Example 1: Leaky woody dams slow the flow and connect a stream with its floodplain, but also provide habitat for fish. They are designed with fish passage issues in mind.
- Example 2: Soil husbandry advice to improve land management leads to increased infiltration and reduced run-off, and reduced mobilisation of sediment particles and associated nutrients.
- Example 3: Where suitable, bunds constructed to attenuate water have been seeded with wild flower mixes to provide additional food sources for pollinators.
- Example 4: Restoring historic water meadows helped to store water but also improved aesthetic value and cultural activities.

How much habitat has been created, improved or restored?

These figures have not yet been calculated.

8. Maintenance, monitoring and adaptive management

Are maintenance activities planned?

Maintenance activities are planned for 5 years and are the landowner's responsibility. Technical information sheets are provided with specific maintenance advice. The grant funding contract specifies that structures must be maintained for 5 years, but structures are built to last beyond 5 years. Where possible, further funding is accessed, for example, Countryside Stewardship funding.

Is the project being monitored?

Hills to Levels is mainly a delivery project with most of the funding and adviser time being spent working with landowners and farmers advising, designing and constructing WWNP/NFM schemes.

The effectiveness of individual measures will be demonstrated by a range of practical methods.

- **Soil structure and infiltration:** infiltration tests and visible evaluation of soil structure (VESS score)
- **Water attenuation:** calculate the water storage capacity of structures during design and observe if they are functioning as intended. Time-lapse fixed photography will be used to show the functioning of structures over time.
- **Run-off filtration:** the accumulation of soil behind filter fences/coir rolls/filter Soxx™ will be measured.
- **Habitat improvement in-stream:** Habitat score before and after in the stretches where improvement schemes were delivered.

Catchment-scale monitoring will be attempted or conducted in small targeted subcatchments and linked to modelling under a PhD. The target catchments have been chosen based on existing Environment Agency flow and level gauges at the catchment outlet with existing baseline flow data. Either existing rain gauges will be used or members of the local community will be provided with rain gauges.

Has adaptive management been needed?

A few sites have needed adaptive management. For example, one bund to attenuate water in a leaky pond was suffering from wave action and had subsequently slumped. Pre-planted coir matting was added to stabilise the banks and has proved a great success. At design stage, the use of coir matting is suggested in similar situations. Adaptive management has been possible because:

- the project team has good working relationships with the farmers/landowners within and beyond this project, enabling the 2-way process of ongoing advice
- the funding requires a site visit to approve the structure
- the funding is flexible to allow for follow-up visits and further funding applications for adaptive management if problems arise

9. Lessons learnt

What was learnt and how could it be applied elsewhere?

The success of NFM depends on the landowner engagement and landowners taking ownership of their structures. Spending most project funding on modelling to find the best sites may not be cost-effective, as the money could potentially be wasted if landowners are not interested in taking part. Local knowledge is often very valuable.

In general, the engagement of farmers/landowners has been very high. The project funding enabled design and funding decisions to be made on a case-by-case basis to suit each scheme to its site and farmer/landowner, and to provide specific management and maintenance advice for each structure.

More could be achieved if current agricultural subsidies (Basic Payment Scheme) and agri-environment schemes (Countryside Stewardship) were more geared up to supporting WWNP/NFM. In many cases, land areas that have been turned into floodplain storage areas or leaky ponds become permanent ineligible features under the Basic Payments Scheme. Constructing such features is only attractive to farmers/landowners who do not rely on the Basic Payments Scheme as income or on sites that are already ineligible. In addition, it would be ideal if both Mid and Higher Tier Countryside Stewardship could include WWNP/NFM options to ensure funding for the management and maintenance of WWNP/NFM structures.

Working with all partners and setting up a technical advisory group can help deliver multiple benefits, utilise expertise that is already there and streamline application process (consents, planning permission).

Partnership working is helpful so that farmers get their trusted adviser to contact them about WWNF/NFM rather than a new person. Merging the project with Countryside Stewardship funding has proved a major benefit for delivery and impact on the ground.

10. Bibliography

ENVIRONMENT AGENCY, 2009. *Parrett Catchment Flood Management Plan*. Exeter: Environment Agency.

ENVIRONMENT AGENCY, 2012. *West Somerset Catchment Flood Management Plan*. Exeter: Environment Agency.

Hills to Levels project website: <http://www.hillstolevels.co.uk/> [Accessed 31 March 2017].

Hills to Levels YouTube channel: <https://www.youtube.com/channel/UCQzUFXhjlwqsahY4JGQgkWw> [Accessed 31 March 2017].

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](#).