Natural Flood Management Measures

A practical guide for farmers and landowners in the Anglian region

Wetland creation, Spain's Hall, Essex. Source: H.George

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Foreword

This guide has been developed by the Environment Agency to provide simple, clear information on Natural Flood Management (NFM) measures for landowners, farmers and anyone with an interest in implementing NFM. It was recognised that such guidance was lacking for our lowland Anglian landscape and so this document has been created for use by practitioners in the Anglian region.

Part of the reform of the UK's agricultural policy since leaving the EU is the phased introduction of Environmental Land Management Schemes (ELMS). The ELM offer is comprised of the Sustainable Farming Incentive (SFI), a revised Countryside Stewardship (CS) scheme and the Landscape Recovery scheme. SFI and CS offer payments to land managers to deliver additional environmental goods and services alongside food production. The revised CS scheme will include NFM actions that will provide capital and revenue payments for land managers undertaking NFM measures on their land.

This document aims to highlight what tools are available that meet the twin challenge of delivering for the environment (specifically through Natural Flood Management), whilst also maintaining current levels of food production.

All information contained in this publication - including links to websites and further reading – is believed to be correct at the time of going to press. This document is based on the publication 'Natural Flood Management Measures – a practical guide for farmers (2017).

Environment Agency

Catchment Sensitive Farming
Working together for a healthy environment

Anglian (Eastern) Regional Flood & Coastal Committee

Online water storage area in normal conditions on the Camping Beck, Buxton, Norfolk. Helen George, EA

Online water storage area in use following a peak rainfall event, Helen George, EA

For more information about Working With Natural Processes and the current state of scientific evidence behind it please follow this link:

https://www.gov.uk/flood-and-coastal-erosion-risk-management-research-reports/working-with-natural-processes-to-reduce-flood-risk

Introduction

Floods are nothing new. Humans have lived with extreme weather for thousands of years. However, climate change science predicts an increase in occurrence and severity of high rainfall events. Subsequent increases in extreme flooding will follow suit.

Within the UK, our flood defence system includes large-scale, hard engineered solutions in and around major cities, flood banks and small scale engineered solutions for rural communities and farmland, and coastal engineering. There is increasing political and public interest in how the management of the wider countryside can contribute to the UKs flood defence system, with particular reference made to Natural Flood Management (NFM).

What is natural flood management?

NFM aims to reduce the downstream maximum water height of a flood (the flood peak) or to delay the arrival of the flood peak downstream, increasing the time available to prepare for floods.

This is achieved by restricting the progress of water through a catchment using a range of techniques. These techniques work with the natural features of the catchment to slow down or store flood waters. They rely on one, or a combination, of the following underlying mechanisms:

1. Increasing soil infiltration: free-draining soil will make saturation less likely, potentially reducing surface runoff.

2. Evaporation from vegetation and soil can also make space for water.

3. Slowing water: by increasing resistance to its flow - for example, by planting floodplain or riverside woods, using woody debris to slow flow-pathways.

4. Storing water by using, and maintaining the capacity of, ponds, ditches, embanked reservoirs, channels or land.

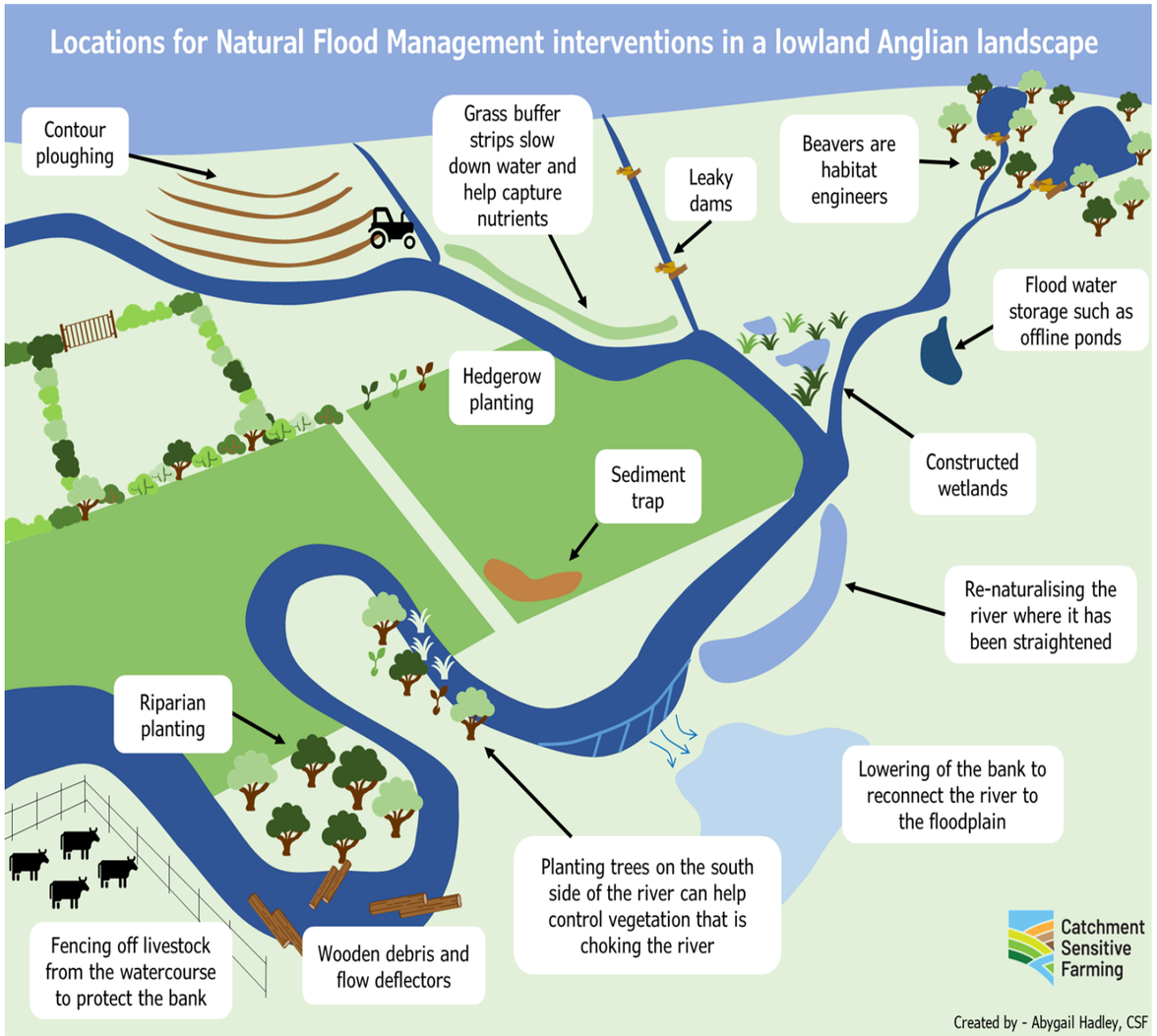
5. Reducing water flow connectivity by interrupting surface flows of water - for example, by planting buffer strips of grass or trees.

Working with natural processes

NFM involves using various techniques to restore or mimic the natural functions of rivers, floodplains, and the wider catchment. It aims to store water in the catchment and slow the rate at which water runs off the landscape into rivers, to help reduce flood risk to communities downstream. NFM is also referred to as 'working with natural processes', 'slow the flow', 'sustainable land management' or 'upstream management'.

NFM structures have been designed so that they do not significantly impact on farming, are typically small in size, and can be considered an extension to the farm's land drainage system. Each structure or technique performs a small amount of runoff storage or attenuation, gradually releasing flood water over 12 to 24 hours. It is the collective network, rather than individual features, that aims to provide flood mitigation in the immediate vicinity and further downstream.

NFM is not the complete solution to flooding, but is one of many tools needed to manage flood events. These tools are more effective at reducing the frequency of flooding for high probability fluvial events (e.g. less than a one in twenty year return period or events that have a 5% chance of occurring each year) compared to extreme events (e.g, a one in 200 year return period or events that have a 0.5% chance of occurring each year). Used in conjunction with other flood management solutions, NFM will have a beneficial impact on slowing the flow of flood water downstream.



Why land management in East Anglia can play its part

East Anglia is a predominantly rural area with more than 50% of land being used for nationally important agriculture and horticulture. Much of the land is low-lying. It includes many interconnected rivers, lakes, groundwater, and coastal waters. In certain areas, rivers can be affected by both tidal and rainfall flooding.

In the region, many communities and land areas are at increasing risk of flood, meaning flood management interventions are more important than ever.

As a farmer, land manager or person with an interest in NFM you may be able to join those implementing NFM measures and help contribute to flood prevention in our area. As the network of NFM installations increases, this could have a significant impact across the catchment.

Using the handbook

This handbook has been developed to provide the advice and key information needed to aid decision-making, should you wish to install natural flood management features on your farm. We have included funding sources to support the work you may want to undertake.

The various measures have been grouped into three different levels of intervention:

Level 1 – Measures requiring minimum or no consultation with authorities such as the Environment Agency (EA). These measures are usually low cost and simple to install, but extremely effective.

Level 2 – Measures requiring a certain level of consultation and possibly consent of authorities (see summary of consents section). These measures are a mix of low to medium cost and may need contractors' help to install them.

Level 3 – Measures involving a level of design that is targeted to certain locations within the catchment, requiring planning permission and consents from authorities, and, in most cases, involving professional water management consultant advice. These measures are usually high cost and need contractors to install them.

Each measure is described in terms of its flood management effectiveness, its benefit to agricultural production, and its overall cost. Set up and maintenance costs have been colour-coded, with the definition provided here:

Set up costs:

High	Requires significant raw materials, specialist equipment, or expert involvement
Medium	Requires some raw materials, specialist equipment, and/or expert involvement
Low	Land manager can implement system with minimal advice, equipment, and specialist material.

Maintenance costs:

High	Expert advice or equipment required to be brought in frequently (e.g. < 5 yrs)
Medium	Expert advice or equipment required to be brought in occasionally (e.g. < 10 yrs)
Low	Mostly involves routine inspections and low-grade management, which can be undertaken by the land manager.

Opportunity mapping

Speak to your local EA contact helen.george@environment-agency.gov.uk for more information about opportunity mapping near you.

Help us keep track

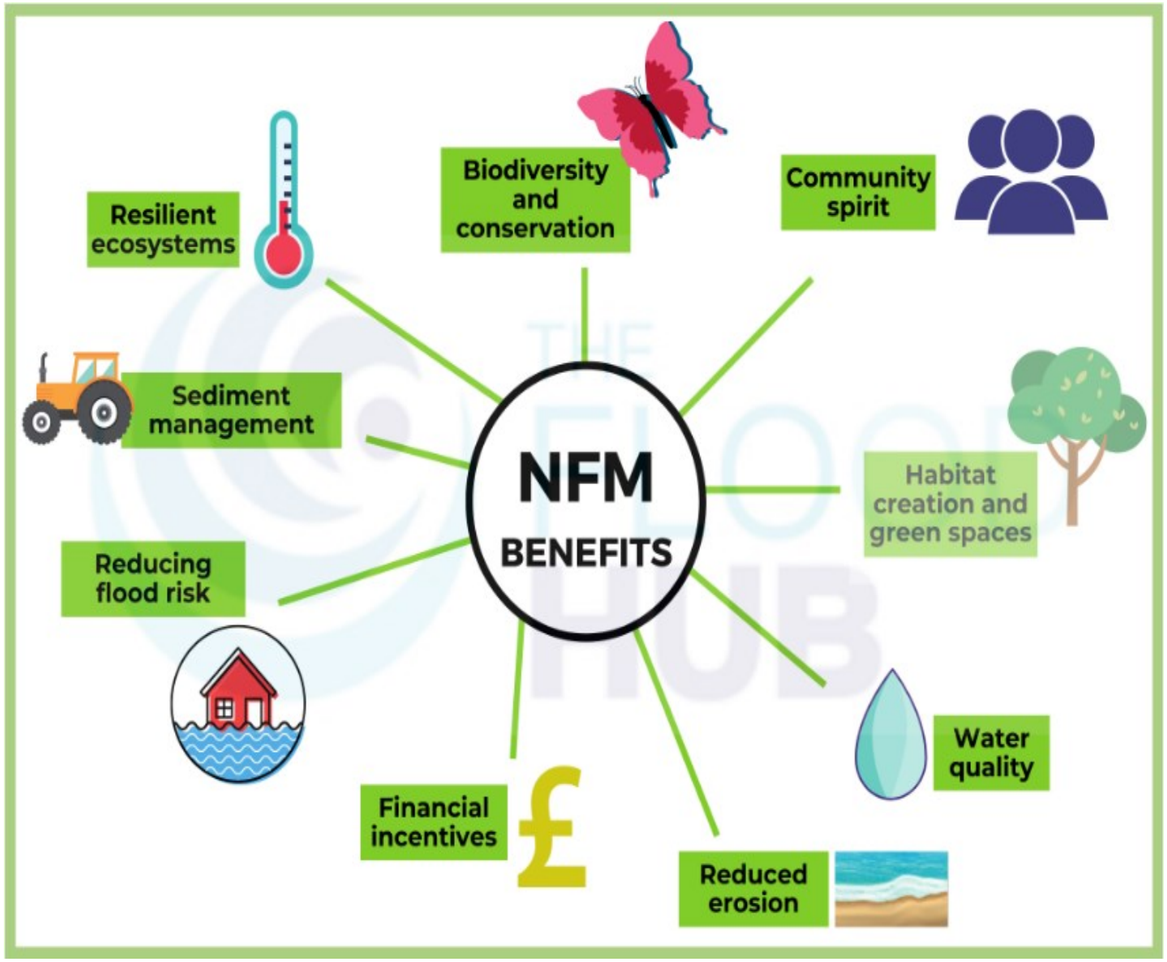
Please keep us updated! If you choose to implement a natural flood management technique on your land, let us know:

- the date of construction
- which treatment was implemented
- the size and number of treatments implemented.

This will help us monitor the use of NFM in our area, and enable us to evaluate the success. Please contact helen.george@environment-agency.gov.uk

Multiple benefits (ecosystem services)

As well as managing and reducing flood risk, there are various other advantages to using NFM techniques in a catchment. They provide a range of benefits to people and the environment, from providing public amenities to increasing biodiversity. https://thefloodhub.co.uk/nfm



MULTIPLE BENEFITS OF NATURAL FLOOD MANAGEMENT

Biodiversity and conservation

Wetlands are one of the most biologically diverse ecosystems due to their unique ecological features and nutrient cycling processes which supports various plants and animals. Woodland creation encourages development of a wide range of species beneath the tree canopy. Improved water quality also has the potential to improve in stream habitats for wildlife.

Financial incentives and capital gains

The Countryside Stewardship Scheme has a range of grants for farmers and land managers who wish to adopt NFM techniques. These can be capital items or management options, for example in-stream structures or river bank restoration. Facilitation funds may be available in your area to assist with your application and provide up to a 20% uplift to your score.

Reducing flood risk

NFM can help to slow the flow of water through a catchment by reducing run off and increasing the ability of catchments to hold water, which can help to reduce river peak flows.

Habitat creation and green spaces

Creating habitats such as wetlands, which are one of the most biologically diverse ecosystems, not only improves biodiversity but also improves connectivity between wetlands, allowing more species to move between habitats. Developing green spaces also has massive social benefits, providing better access to green spaces, improving the environment we live in and improving quality of life.

Improving water quality

Improvements in soil structure through woodland creation or less intensive land management increases rates of infiltration. Reconnection of wetlands can help to manage high nutrient loads and reduce siltation, contributing to improvements in the status of water bodies.

Community spirit

Making small adjustments to your land management or allowing unproductive land to be used for flood storage can make a difference to those in the community at risk of flooding further downstream, particularly if several landowners work together to implement NFM measures.

Reduced erosion

NFM can help restore coastal sediment processes and morphology. Saltmarshes and mudflats help reduce wave energy at shorelines, sand dunes act as natural buffers for cliffs from waves, and beach nourishment restores the natural coastal defence function of beaches.

Resilient ecosystems

Wetlands and woodlands are efficient at accumulating and storing carbon and removing carbon dioxide from the atmosphere. Measures that reduce surface runoff and soil erosion, such as contour cultivation, can also reduce carbon loss from soil.

Sediment management

NFM can improve soil structure, reduce loss of top soil and increase soil productivity which can in turn increase agricultural productivity. Measures such as run off pathway management and offline storage areas can help with sediment capture, preventing soil erosion and loss of sediments and fertilisers into the watercourse.

NATURAL FLOOD MANAGEMENT

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Last reviewed: January 2024
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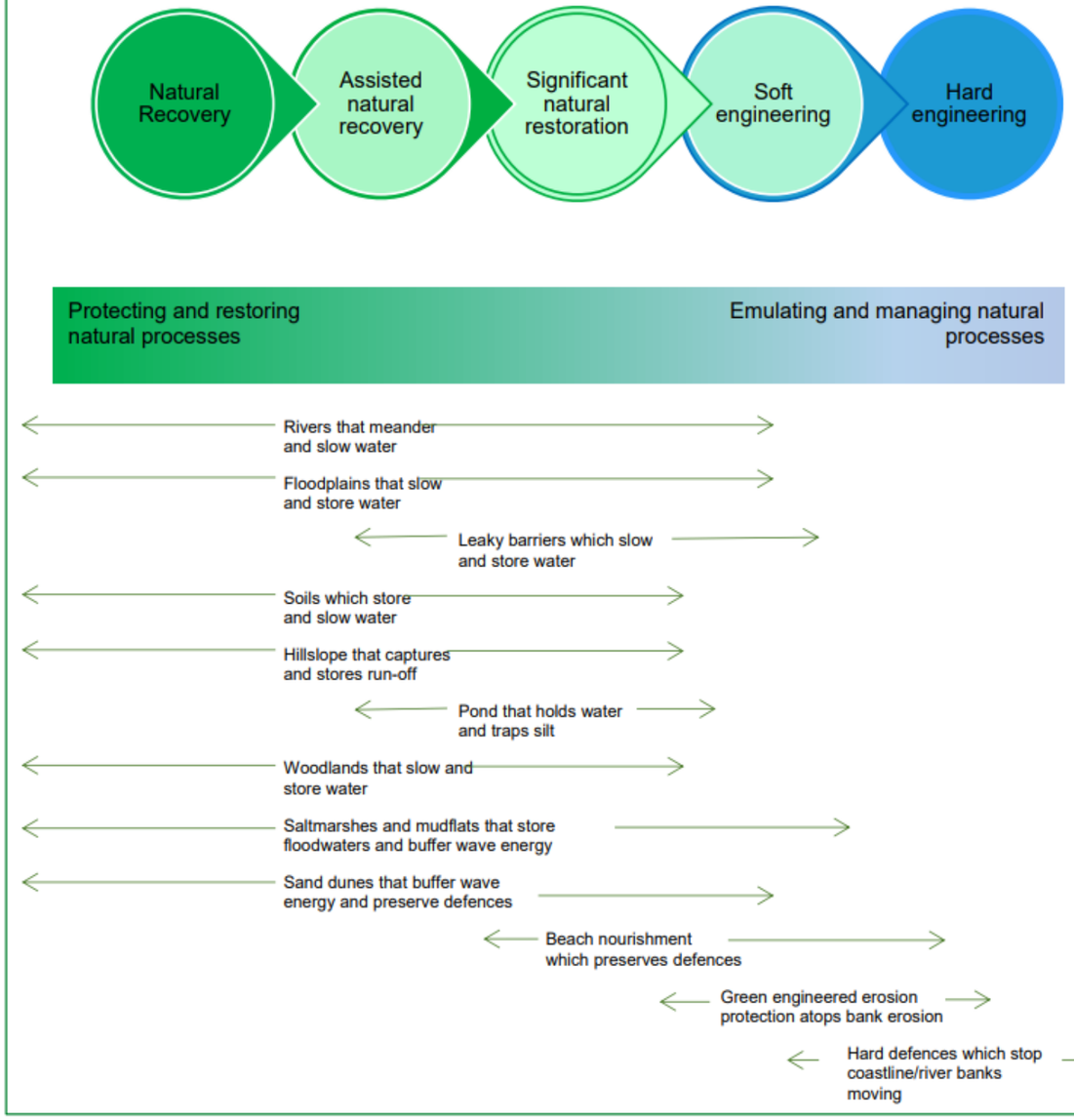


The Working with Natural Processes/NFM spectrum above gives an indication of where specific techniques fit in terms of how natural or engineered they are. All come with their own set of benefits.

The benefits wheels in the following examples cover 10 benefit indicators, which have been ranked on a scale from 1 to 5 to give an indication of the relative contribution the measure can make to the provision of a certain benefit (assuming the measure is well planned, designed and maintained). This approach is an adapted version of that developed for the Westcountry Rivers Trust's ecosystem system toolbox (Westcountry Rivers Trust 2016).

The scores used to derive the benefits wheels are based on findings from current literature and discussions with the project steering group who quality assured the scores given. The wheels are included to give the reader a quick visual impression of the types of benefits the measure could achieve.

1.1 Increasing soil permeability: reducing soil compaction

Think Soils, EA

Natural Flood Management purpose

- Managing soil compaction is one of the most effective treatments farmers can undertake to reduce overland flow and lower flood risk at a local scale.
- It can help to increase the amount of water held in the soil over a wide area.
- It also improves connectivity with groundwater by promoting strong root growth.

Agricultural benefits

- Increase yields, crops and grass
- Increase grass competitiveness against rushes
- Reduce soil erosion, keeping a valuable resource where it should be
- Reduced loss of fertilisers and pesticide into nearby ditches and burns, saving you money
- Better soil infiltration, reducing waterlogging so the field may be accessible earlier in the season.

Considerations

Change or vary tillage practices on the field e.g. minimum tillage or vary ploughing depths

FACT: Runoff from compacted soils is 50-60% higher than on aerated healthy soils**

Compaction is where soil has been squashed into a solid, impermeable layer, either at the surface or within the topsoil. This band restricts the movement of air, water and nutrients down through the soil profile. The effects of soil compaction can be detrimental to grass and root growth, reducing the ability of grass to pick up nutrients—particularly nitrogen and water—from the soil. It creates conditions for waterlogging and poaching and increases the risk of runoff, leading to soil and nutrient loss. Wet soils stay colder for longer, reducing the number of available grazing days. They can also make harvesting difficult, which is likely to reduce the quality of the resulting silage or crop. Soil compaction can be caused by a range of things, from grazing livestock to farm machinery.

Runoff from field. Source: River Waveney Trust.

Method

- Undertake soil test to identify pH; consider adding lime if it's below 6. This encourages separation of soil particles from one another, creating air pockets.
- Mechanically aerate soils using spiked aerators, subsoiler or sward lifter, depending on the depth of compaction.
- Undertake minimal tillage for arable crops or when considering re-seeding.
- Managing crop and livestock rotation can help to reduce compaction, while also improving soil fertility and yield.
- Avoid using heavy machinery on wet soils **and use low pressure tyres** to further protect from compaction.
- Consider re-seeding or overseeding using deep rooting plant species – e.g festulolium and clovers for grassland.

Costs

Set up costs:	Maintenance costs:
Low	Low

Level of maintenance required

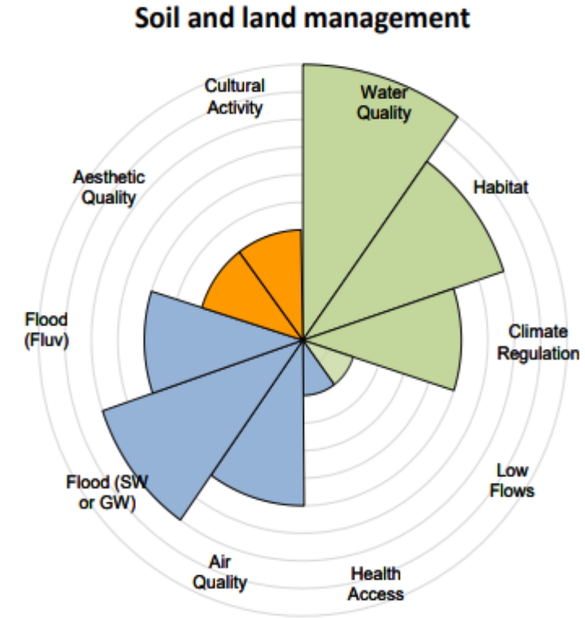
Low

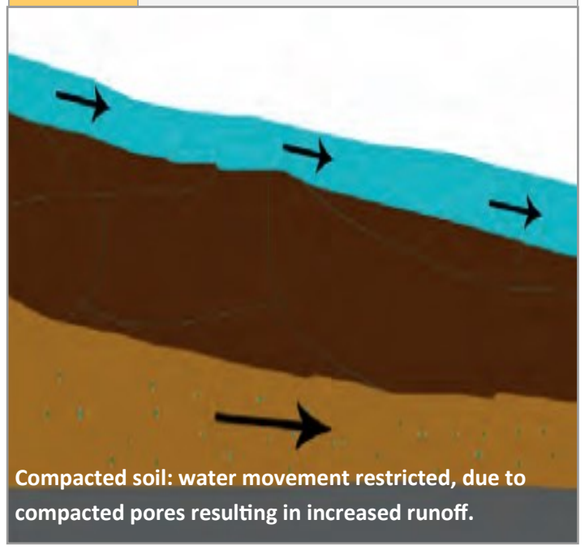
Funding

There are a range of financial incentives available through Environmental Land Management (ELM) that contain a range of options for Soil Management. See links below and on pages 13, 15 and 17.

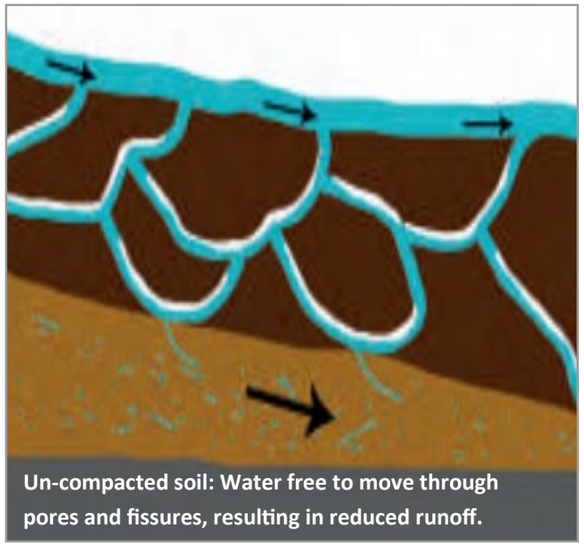
Benefits summary

Environmental	**Water quality improvement:** improved infiltration and sedimentation, retaining eroded particles carrying pesticides and phosphorus.
Social	**Reduced risk of fluvial, surface water and groundwater flood:** Improved soil stability, less surface run-off and more infiltration. **Air quality:** Soil conservation reduces wind erosion.
Cultural	**Aesthetic & cultural value:** where accessible, improved landscape aesthetics provides opportunities for physical activity and mental relaxation.





Compacted soil: water movement restricted, due to compacted pores resulting in increased runoff.



Un-compacted soil: Water free to move through pores and fissures, resulting in reduced runoff.

Additional Information

https://www.gov.uk/countryside-stewardship-grants/winter-cover-crops-sw6
https://www.gov.uk/countryside-stewardship-grants/equipment-to-disrupt-tramlines-in-arable-areas-rp31
https://www.gov.uk/countryside-stewardship-grants/in-field-grass-strips-sw3
https://ahdb.org.uk/projects/documents/ThinkSoils.pdf
https://www.gov.uk/government/publications/agricultural-transition-plan-2021-to-2024/technical-annex-the-combined-environmental-land-management-offer#species-recovery-and-management
**Agriculture and Horticulture Development Board (AHDB), 2016

1.2 Creating and managing buffer strips

Buffer strips either side of a field drain at Withersfield, Suffolk. Source: R. Dryden, EA.

Natural Flood Management purpose

- Vegetation in the grass strip increases the roughness of the land surface, which slows the flow of runoff and increases infiltration.
- Buffer strips trap sediment and reduce sediment flow into watercourse.
- They stabilise the banks of watercourses, helping prevent erosion and siltation from bank material.

Method

Riparian buffer strips should be a minimum of 4m wide for maximum effect, and may require fencing to exclude livestock from the river banks.
In-field buffer strips should be 2m wide.
Planting native tree species within the buffer strip increases benefits for NFM and wildlife.

Key locations

- Throughout the catchment, adjacent to rivers, and especially on grazed land next to streams and ditches that suffer from high sediment loads.
- In-field strips on arable land at risk from soil erosion. This option works well alongside other run-off intercepting options, such as contour bunds and hedgerows.
- Creating a network of grass strips next to watercourses and ditches - known as riparian buffer strips - can provide a physical barrier that helps restrict the flow of storm water, carrying sediment and nutrients, and preventing them from being washed from the field into the watercourse.

- In-field buffer strips, as their name implies, are found adjacent to field boundaries and across fields. They can reduce overland flow impacting roads and neighbouring properties.

Agricultural benefits

- Buffer strips trap and filter runoff, preventing loss of fertilisers, sediment and pesticides. Ten metre wide strips reduce sediment loss by 30%.
- They reduce frequency of ditch management through decreased rates of siltation and weed development from increased nutrient levels.
- They enhance crop management operations by straightening irregular field edges.
- They control or prevent erosion of valuable top soil from fields into watercourses, so reducing contamination by silt and organic wastes.
- They help reduce nitrate leaching by vegetation growing on the buffer strip absorbing nitrogen.
- They create wildlife corridors and sites for ground nesting birds, small mammals and beneficial pollinator insects.
- They reduce effects of spray drift.
- By building a small mound down the in-field buffer strip, a beetle bank can be created, further benefiting the wildlife and encouraging natural predators of crop-eating insects.

Considerations

- Implementation next to main rivers may require Environment Agency consent, if it is to be fenced against livestock.
- Shrubs such as hawthorn and hazel interspersed with alder, willow and birch are beneficial for slowing runoff and stabilising riverbanks.
- Maintenance of field buffer strips will depend on the land use, but fertilisers and manures should not be used.

Costs

Set up costs:	Maintenance costs:
Low	Low

Level of maintenance required

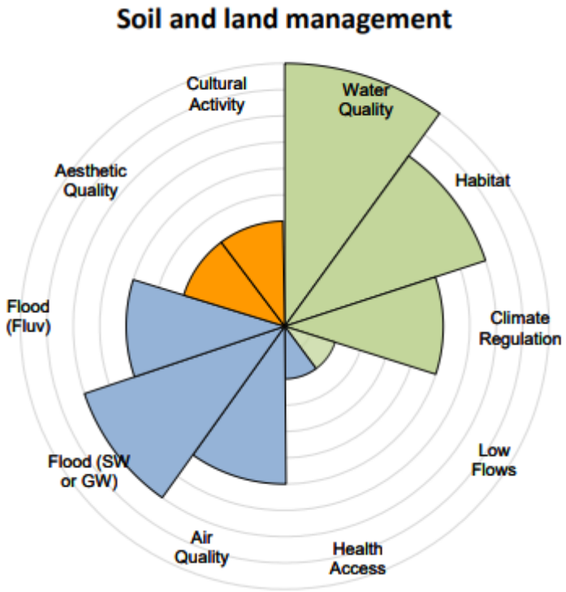
Low

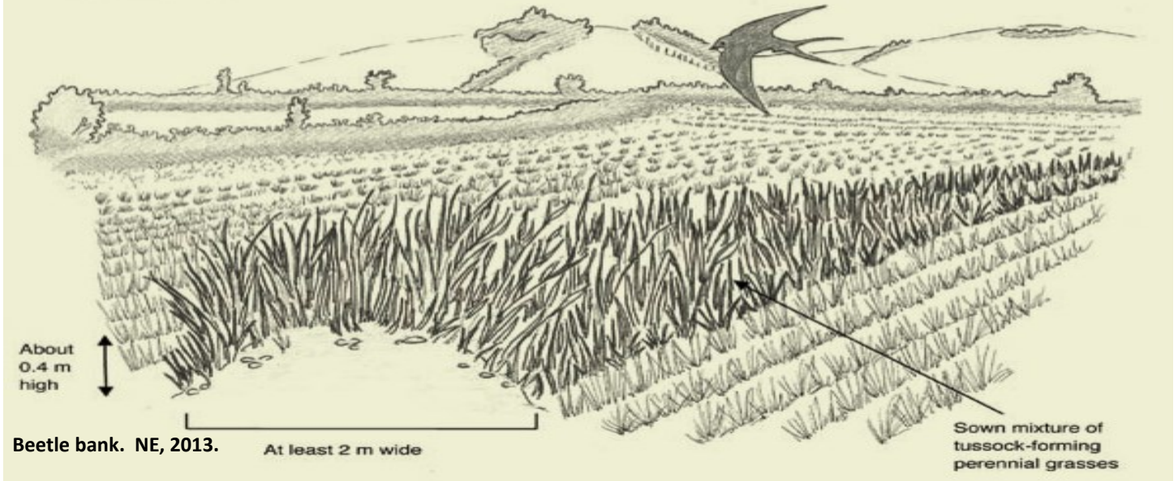
Funding

Environmental Land Management (ELM) contains a range of options for creating and managing buffer strips, grass margins and riparian management strips. See links below for more information.

Benefits summary

Environmental	**Water quality improvement:** buffers improve infiltration and sedimentation, retaining eroded particles carrying pesticides and phosphorus. **Habitat provision:** for pollinators; birds, invertebrates.
Social	**Reduced risk of fluvial, surface water and groundwater flood:** Improved soil stability, less surface run-off and more infiltration **Air quality:** reduces wind erosion, contributing to improved local air quality.
Cultural	**Aesthetic & cultural value:** where accessible, improved landscape aesthetics provides opportunities for physical activity and mental relaxation.





Beetle bank. NE, 2013.

https://www.gov.uk/countryside-stewardship-grants/4m-to-6m-buffer-strip-on-cultivated-land-sw1
https://www.gov.uk/countryside-stewardship-grants/riparian-management-strip-sw11
https://www.gov.uk/countryside-stewardship-grants/12m-to-24m-watercourse-buffer-strip-on-cultivated-land-sw4
https://www.gov.uk/countryside-stewardship-grants/buffering-in-field-ponds-and-ditches-on-arable-land-wt2
https://www.gov.uk/countryside-stewardship-grants/beetle-banks-ab3
https://www.cfeonline.org.uk/environmental-management/grass-buffer-strips-next-to-a-watercourse-or-pond/
www.cfeonline.org.uk/2-in-field-grass-strips-to-avoid-erosion
https://defrafarming.blog.gov.uk/create-and-maintain-beetle-banks/
https://www.gov.uk/government/publications/agricultural-transition-plan-2021-to-2024/technical-annex-the-combined-environmental-land-management-offer#species-recovery-and-management

1.3 Planting and managing hedgerows

Newly planted hedge. Source: W.Baxter, Wiki-media Commons.

Natural Flood Management purpose

- Hedgerows provide excellent natural weather barriers and habitat for wildlife, but also perform a natural flood management function by intercepting rainfall, slowing overland runoff and increasing infiltration.
- Hedgerows trap sediment, reducing the amount of sediment and diffuse pollution reaching watercourses.

Method

- Prepare the ground along a 1.5m wide strip to provide good soil conditions and as little competition from other vegetation as possible.
- Plant a double staggered row hedge using 6 plants per metre.
- Up to 75% of the species can be thorns – for example, hawthorn and blackthorn.
- Consider a mix of shrub species, including hazel, geulder rose, rowan and holly, to enhance the hedgerow for wildlife.
- Add in an oak, lime, aspen or alder every 10 m to grow out into a single landscape tree for additional future shade and shelter.
- Use a 1.2 m guard to protect the standard tree as it grows.
- Fence off the plants, keeping fences far enough away so the hedgerow can grow at least 2 m in width.
- Rabbit netting may be needed, either on its own or with stock fencing, if there is a known problem with rabbits or hares.
- Remove individual guards and tree shelters once the plants are established.

Considerations

- Planting should be carried out between November and March.
- Up to 75% of the species can be thorns – for example, hawthorn and blackthorn.
- Consider a mix of shrub species, including hazel, guelder rose, rowan and holly, to enhance hedgerow for wildlife.
- Hedgerows are an intrinsic part of the landscape and in many places owe their existence to the need to divide grassland into conveniently-sized grazing pastures for livestock.
- If new hedgerows are planted consider linking existing hedgerows and habitats.

Key locations

- Across a slope where runoff occurs or perpendicular to the river in a floodplain.
- Where hedgerows have been lost from an area or the network is very fragmented.
- Also consider restoration and management in areas where there are good networks of hedgerows.

Agricultural benefits

- Hedgerows create areas of shelter and shade for livestock.
- They trap and filter runoff, preventing loss of fertilisers, sediment and pesticides.
- Animal health may also be improved through reductions in standing water from increased infiltration rates.
- They can reduce the impact of wind erosion on sandy soils.
- Hedgerows provide a barrier to the spread of disease, reducing animal-to-animal contact.
- They provide habitat for farmland birds and beneficial insects.
- Combined with adjacent sown or unploughed field margins, hedgerows are of far greater value for wildlife providing the link between nesting, feeding and refuge zones.

Costs

Set up costs:	Maintenance costs:
Medium	Low

Level of maintenance required

High:

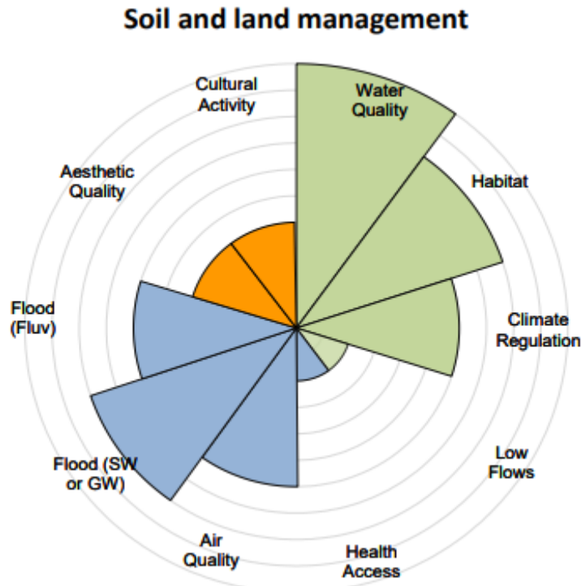
- Newly planted hedges will require annual maintenance until at least 1.5m tall, particularly with regard to weed control, cutting every two years from then on to ensure life of hedgerow.
- Cutting to a box shape will increase benefits for wildlife, as well as shelter for stock.
- The laying of hedge every 8-15 years will increase wildlife benefits and the overall health of the hedge.

Funding

There are a range of financial incentives available through Environmental Land Management (ELM) that contain a range of options for Planting and Managing Hedgerows. See links below for more information and payment rates:

Benefits summary

Environ-mental	**Water quality improvement:** Hedges improve infiltration and sedimentation, retaining eroded particles carrying pesticides and phosphorus. **Habitat provision:** for pollinators; birds,
Social	**Reduced risk of fluvial, surface water and groundwater flood:** Improved soil stability, less surface run-off and more infiltration. **Air quality:** reduces wind erosion, contributing to improved local air quality.
Cultural	**Aesthetic & cultural value:** where accessible, improved landscape aesthetics provides opportunities for physical activity and mental relaxation.



Additional Information

https://www.gov.uk/countryside-stewardship-grants/hedgerow-laying-bn5
https://www.gov.uk/countryside-stewardship-grants/hedgerow-coppicing-bn6
https://www.gov.uk/countryside-stewardship-grants/hedgerow-gapping-up-bn7
https://www.gov.uk/countryside-stewardship-grants/planting-new-hedges-bn11
https://www.gov.uk/guidance/england-woodland-creation-offer
https://www.woodlandtrust.org.uk/plant-trees/trees-for-landowners-and-farmers/morehedges/
https://www.gov.uk/government/publications/agricultural-transition-plan-2021-to-2024/technical-annex-the-combined-environmental-land-management-offer#species-recovery-and-management

1.4 Cover crops

Phacelia tanacetifollia. Source: A. Curtis, Wikimedia Commons.

Natural Flood Management purpose

Cover crops reduce runoff rates and overland flow, reduce erosion, increase infiltration and water storage capacity. A cover crop is grown between main crops to protect soils and the environment, reduce flood risk and improve subsequent crop yields .

Key locations

- Works well on arable or temporary grassland adjacent to watercourses, particularly on sloping fields.
- Where water is seen to flow across the surface in high rainfall events in lower parts of a catchment.
- Sow cover crops after harvest in flood prone areas to protect soils and nutrients losses

Method

Sow any plant that has the ability to grow throughout the winter. Leaving crop residues throughout winter can also act to protect the soil surface and increase infiltration. You can use phacelia, vetch, ryegrass, grazing rye, barley and mustard, or a mix of these depending on local conditions and needs.

Do not destroy until immediately before establishment of following spring crop.

Agricultural benefits

A cover crop is a non-cash crop grown primarily for the purpose of 'protecting or improving' the soil in between periods of regular crop production. Cover crops can be used repeatedly as part of an arable rotation's long-term strategy to reduce winter runoff and soil loss, improve soil quality and organic matter, and provide other benefits. Agriculture & Horticulture Development Board (AHDB), 2015. Cover crops can be a cost effective method to protect your soil stability and subsequently reduce sediment runoff from the farm. This in turn reduces the soil and nutrients lost from farm, which can save money. By having the field in crop, the soil is able to retain moisture, therefore, reducing the rate of water runoff from the farm. This can help reduce flood peaks further downstream.

Considerations

Deep-rooting plants will provide additional benefits by loosening compacted soils. Using cover crops may require altering the arable rotation away from winter drilling towards spring.
Cover crops can be used repeatedly as part of an arable rotation's long-term strategy.

Costs

Set up costs:	Maintenance costs:
Low	Low

Level of maintenance required

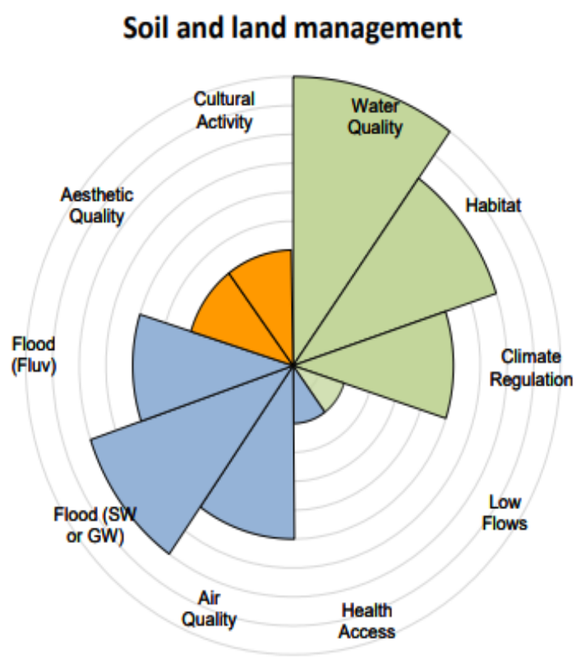
Low

Funding

There are a range of financial incentives available through Environmental Land Management (ELM) , see opposite page for links to options and payment rates.

Benefits summary

Environmental	**Water quality improvement:** stabilise soils, reduce erosion, absorb nutrients that would otherwise reach a watercourse. **Habitat provision:** for pollinators; birds, invertebrates.
Social	**Reduced risk of fluvial, surface water and groundwater flood:** Roughness of vegetation cover slows runoff rates and reduces overland flow. **Air quality:** Soil conservation reduces wind erosion.
Cultural	**Aesthetic & cultural value:** where accessible, improved landscape aesthetics provide opportunities for physical activity and mental relaxation.



Options specific for modifying flow pathways:

https://www.gov.uk/countryside-stewardship-grants/nectar-flower-mix-ab1
https://www.gov.uk/countryside-stewardship-grants/beetle-banks-ab3
https://www.gov.uk/countryside-stewardship-grants/flower-rich-margins-and-plots-ab8
https://www.gov.uk/countryside-stewardship-grants/winter-bird-food-ab9
https://www.gov.uk/countryside-stewardship-grants/autumn-sown-bumblebird-mix-ab16
https://www.gov.uk/countryside-stewardship-grants/wild-bird-seed-mixture-op2
https://www.gov.uk/countryside-stewardship-grants/4m-to-6m-buffer-strip-on-cultivated-land-sw1
https://www.gov.uk/countryside-stewardship-grants/in-field-grass-strips-sw3
https://www.gov.uk/countryside-stewardship-grants/12m-to-24m-watercourse-buffer-strip-on-cultivated-land-sw4
https://www.gov.uk/countryside-stewardship-grants/buffering-in-field-ponds-and-ditches-on-arable-land-wt2

Options specific for increasing infiltration:

https://www.gov.uk/countryside-stewardship-grants/basic-overwinter-stubble-ab2
https://www.gov.uk/countryside-stewardship-grants/enhanced-overwinter-stubble-ab6
https://www.gov.uk/countryside-stewardship-grants/two-year-sown-legume-fallow-ab15
https://www.gov.uk/countryside-stewardship-grants/overwintered-stubble-op1
https://www.gov.uk/countryside-stewardship-grants/enhanced-management-of-maize-crops-sw5
https://www.gov.uk/countryside-stewardship-grants/winter-cover-crops-sw6

Additional reading:

www.cfeonline.org.uk/5-winter-cover-crops
https://cereals.ahdb.org.uk/media/655816/is41-opportunities-for-cover-crops-in-conventional-arable-rotations.pdf

1.5 Cross drains in farm tracks

Cross drain. Source: Norfolk Rivers Trust

Natural Flood Management purpose

- Cross drains divert the main pathway of water, reducing flow volume, velocity and sediment load.
- When used with a sediment trap, they can slow the flow of storm water significantly.
- Cross drains will help reduce channelling of surface runoff and the risk of sediment and other pollution entering a watercourse

Tracks provide a significant transport pathway for water and sediment. This creates problems with erosion of the track and deposition of sediment on farmland, roads or watercourses. Tracks are costly to repair, but are essential to the farm. A cross drain is a system to move water across a path or route and can be used to collect runoff from a vulnerable area.

Key locations

Tracks on hillslopes, adjacent to yards or roads, or within close proximity of a watercourse.

Cross drains should be placed at intervals across sloping tracks. The number of drains will increase with the length or steepness of the slope. The distance between the drains will vary according to the site, but they must be close enough to collect heavy surface flows

Method

The size of the cross drain will depend on local conditions. Position the cross drain so it catches the water on the uphill side of the track or yard and transfers it to an outfall where it will not cause new erosion or runoff issues.

- Redirect water from the cross drain to a stable drainage outlet such as a ditch, culvert or other outfall - low flows can be directed to a field or field margin
- Construct the drain either by digging a partially covered channel to collect sediment and redirect surface water, or by constructing a low hump to direct surface flows
- Maintain drains and drainage outfalls or the areas around humps by removing built-up sediment or other clogging materials
- Either construct an open channel or excavate a channel across the width of the track or in a yard to a depth of at least 100mm and 100mm to 250mm wide
- Line the channel with concrete and install a gridded top that must be at least 150mm wide, or construct a raised hump:
- Excavate a foundation trench across the track or yard to a depth of at least 300mm, fill it with concrete,
- Key in kerbstones across the trench so they protrude 60 to 100mm above the surrounding surface.

Do not:

- Direct any runoff towards any biodiversity, historic or archaeological features (identified on the FER, the Environmental Information Map or the HEFER), or damage them in any other way
- Allow polluted water from drains to reach a watercourse or pond

Agricultural benefits

- Farm tracks suffer from less erosion, less sediment is lost, and they last longer.
- Sediment caught in traps can be re-used on the track, saving time and money.
- Cross drains can keep tracks accessible even in wet periods.
- Installation of cross drains can reduce the likelihood of pollution incidents .

Costs

Set up costs:	Maintenance costs:
Low	Low

Funding

Financial incentives available, see below for links to options and payment rates.

Level of maintenance required

Low:

Cross drains should be inspected, cleaned out, or reshaped to original capacity after each major storm.

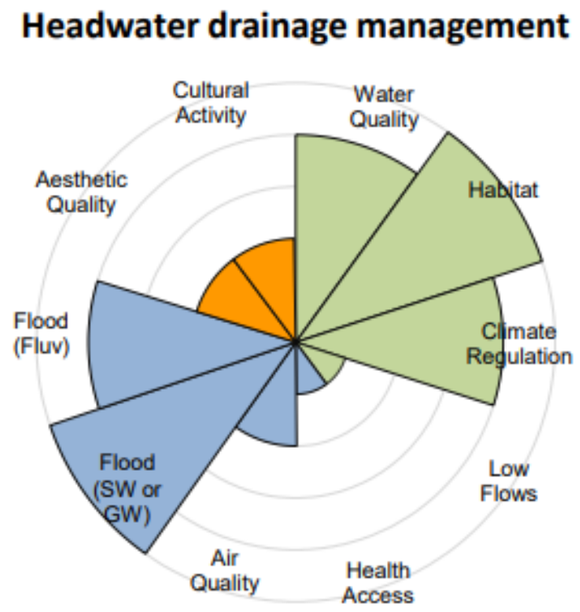
Considerations

On steep slopes or where runoff volume is high, a number of cross drains will be required, located at specific intervals along the track.

They can be linked with swales and sediment traps alongside the track to encourage sediment to drop out of the water. This also prevents sediment being

Benefits summary

Environmental	Reduced sediment/ poor water quality reaching watercourses where sensitive receptors may be present . Beneficial for all aquatic biodiversity
Social	**Reduced risk of fluvial, surface water and groundwater flood:** Can help manage runoff pathways, provide storage and encourage percolation to groundwater.



Additional Information

https://www.norfolkriverstrust.org/wp-content/uploads/2019/10/H2L-Information-Sheet-05-Cross-Drains.pdf

https://www.gov.uk/countryside-stewardship-grants/cross-drains-rp5

https://tmaf.co.uk/new-features-in-the-morley-clean-water-project/

https://www.gov.uk/government/publications/agricultural-transition-plan-2021-to-2024/technical-annex-the-combined-environmental-land-management-offer#species-recovery-and-management

1.6 Using trees

Hillslope tree planting. Weybourne, Norfolk.
Source: H.George, EA.

Natural Flood Management purpose

- Planting of trees increases the roughness of the vegetation, slowing the flow of water during a flood event.
- It reduces the volume of runoff, by promoting rainfall infiltration into the soil and reducing the rate of runoff.
- Well-managed woodland cover can increase the capture and evaporation of rainfall.
- Once tree cover is established, interception can reduce the amount of rainfall reaching the ground by as much as 45%. A reduction of even half of this amount could therefore make a major contribution to flood control.
- Woodland soils typically have a relatively open, organic, rich upper layer, which facilitates the rapid entry and storage of rain water – a 'sponge' effect.
- The roots of bankside trees and associated vegetation help to bind and strengthen stream banks, reducing the risk of bank collapse, erosion and siltation.

Key locations

- Throughout the catchment - in particular, remote upper catchment areas.
- Across slope following a contour.
- Existing woodlands, plantations and shelter belts.
- Alongside watercourses, field margins.

Well-sited and well-managed upland, floodplain and riparian woodland can contribute to the delivery of a host of outcomes. They provide important wildlife habitat, and increased canopy shade and shelter for water-based flora and fauna. They can also provide shade and shelter for livestock, and prevent damage to crops and soil erosion. There is growing interest in the potential to use woodland measures to help reduce flood risk. The Forestry Commission (FC) has been directly involved in a number of trials and demonstration projects – e.g. at Pickering. These projects have shown that looking after existing native woodlands and plantations, and targeting certain areas for tree planting, will significantly slow overland flow of water and reduce river bank erosion within that area.

Agricultural benefits

- Using trees creates areas of shelter and shade for livestock.
- They reduce floodwater damage on productive farm land.
- They trap and filter runoff, preventing loss of fertilisers, sediment and pesticides.

Considerations

- Consider fencing woodland from livestock when trying to encourage tree regeneration and increase vegetation under the canopy. This may only need to be temporary.
- New planting will need protecting from livestock grazing.
- Under-planting of shrubs and young tree saplings improves the infiltration rates of existing woodland.
- For new areas, link up with existing woodland or hedgerows to create a wildlife corridor effect.
- Works well alongside the leaky woody dam technique (See In-channel barriers, page 29-30).

Costs

Set up costs:	Maintenance costs:
Low	Low

Funding

Various financial incentives available, see below for links to options and payment rates.

Methods

The optimum area to be planted varies at each potential site.

Level of maintenance required

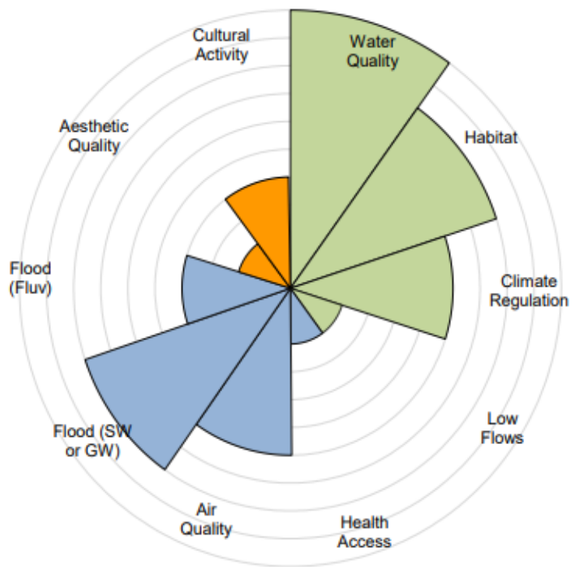
Low: For management of existing woodland

Medium: For new native woodland; this will involve weeding, checking or straightening guards, and replacing failed trees as the plantation becomes established. Guards will need to be removed when the trees are grown.

Benefits summary

Environmental	**Water quality improvement:** Reduces sediment and nutrient loading from upslope. **Habitat provision:** Important habitat for birds, mammals, invertebrates. **Climate regulation:** Carbon sequestration.
Social	**Reduced risk of fluvial, surface water and groundwater flood:** through interception of run-off and increased infiltration. **Air quality:** reduction of pollutants and carbon in air .
Cultural	**Aesthetic and recreational value:** Trees can provide recreation opportunities, aesthetic and health benefits.

Cross-slope woodland



Hillslope tree planting, Weybourne, Norfolk.
Source: H.George, EA.

Additional Information

https://www.gov.uk/guidance/england-woodland-creation-offer
https://www.forestresearch.gov.uk/publications/designing-and-managing-forests-and-woodlands-to-reduce-flood-risk/
https://www.gov.uk/government/publications/agricultural-transition-plan-2021-to-2024/technical-annex-the-combined-environmental-land-management-offer#species-recovery-and-management

2.1 Attenuation basins

Attenuation basin, Cherry Tree Brook, Debenham, Suffolk. Source: H.George, EA.

Natural Flood Management purpose

These systems work by retaining water, which allows sediment to settle before entering watercourses. This also provides a flood risk benefit by holding back water and slowing the flow above communities at risk of flooding.
They are usually dry until a rainfall event, whereby they collect water and store it.

Considerations

- Their design should be tailored to each distinct location, working for example with low spots where water naturally collects.
- Consideration should be given to where the water would go if the storage area becomes full and overtops. These exceedance flow paths should not create a new flood risk area.
- The creation of a bund will also mean the corresponding creation of an attenuation area where water is held while being dispersed through a combination of infiltration, evaporation, and slow release by flow control (for example, small pipe).
- Features can be small or large scale, depending on the size of the catchment area and the local soil conditions.
- The reprofiling of land can be designed so that the attenuation area is normally dry and can remain productive, as well as providing an opportunity for reclaiming soil and nutrients.

- Alternatively, levels can be set to encourage the development of wetland habitat within the flood storage area by permanently retaining water.

Agricultural benefits

- They reduce soil loss and surface scour.
- They filter diffuse pollutants and provide opportunity for nutrient reclamation.
- They provide pollutant treatment by allowing settlement.
- They can be engineered in such a way as to provide access to fields in times of flood which would otherwise be inaccessible

Key locations

Slopes prone to runoff during flood events.
Areas where runoff with a heavy sediment load is

Method

- Design of the bunds or attenuation area should be site specific, taking into account flow pathways whilst working with natural low spots to encourage and enhance the collection and storage of water.
- It should take into account the contour of the surrounding land, the position in the landscape, and the soil type.
- Construction materials will also depend on the size of the detention basin, the method of flow control used, and consideration of future maintenance.
- Detention areas should be appropriately sized for the area draining into it.

Costs

Set up costs:	Maintenance costs:
Medium to high	Low

Level of maintenance required

Dependent on the scale and design : Arrangements for on-going maintenance may need to be submitted as part of any planning application.

Funding

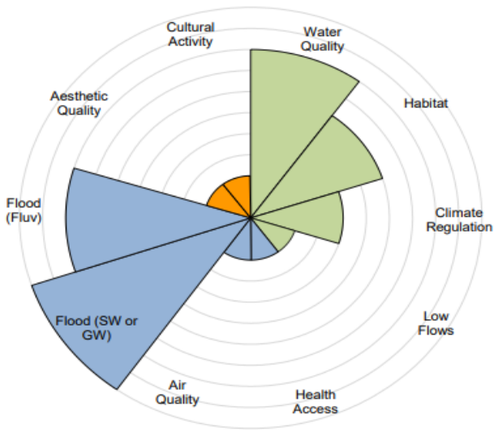
Various financial incentives available, see below for links to options and payment rates.

Benefits summary

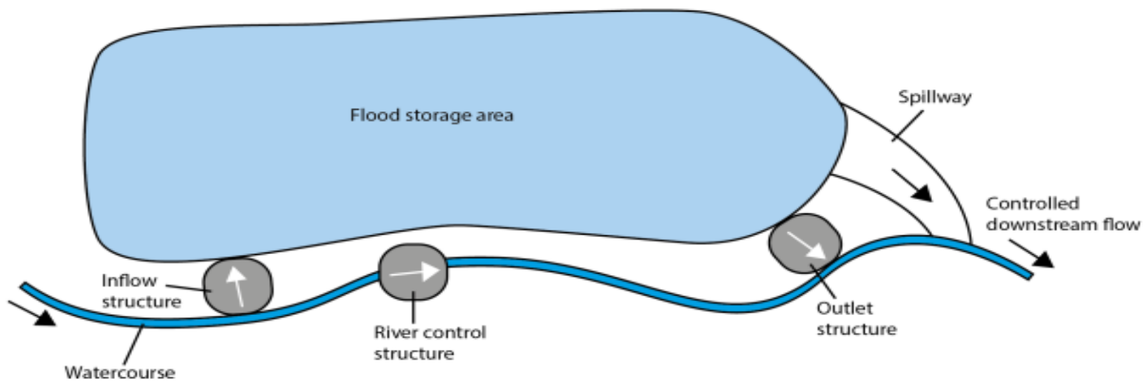
Environmental	**Water quality improvement:** sediment deposition, reduced diffuse pollution **Habitat provision:** creation of habitats for a range of aquatic mammals, amphibians and invertebrates, as well as farmland birds **Climate regulation:** carbon sequestration **Low flow regulation:** permanent features provide storage areas for times of drought. They promote infiltration, enabling groundwater recharge.
Social	**Reduced risk of fluvial, surface water and groundwater flood:** Reduction in flood risk through water storage.
Cultural	**Aesthetic & cultural value:** wetlands are valued as distinctive landscape features and can provide recreation opportunities, aesthetic and health benefits.

Offline storage, Morley Village Hall, Norfolk. Source: S.Halls, Norfolk County Council.

Run-off pathway management



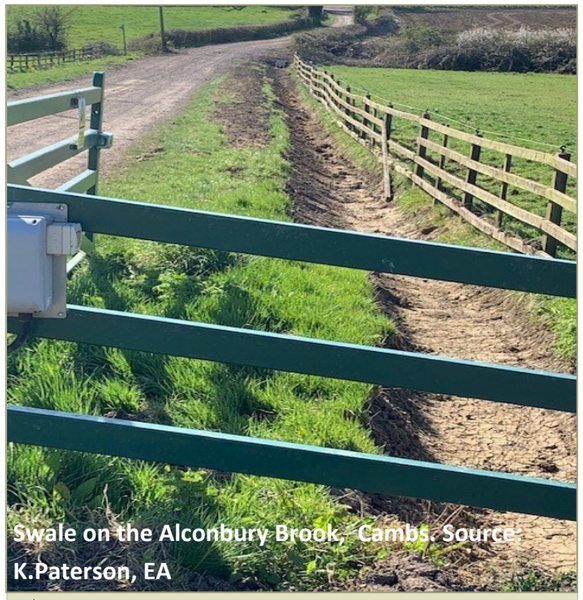
Offline storage



Additional Information

https://www.gov.uk/countryside-stewardship-grants/earth-banks-and-soil-bunds-rp9
https://www.gov.uk/countryside-stewardship-grants/sediment-ponds-and-traps-rp7
www.susdrain.org/resources/ciria-guidance.html
https://www.gov.uk/government/publications/agricultural-transition-plan-2021-to-2024/technical-annex-the-combined-environmental-land-management-offer#species-recovery-and-management
https://www.wwt.org.uk/uploads/documents/2023-03-25/wwt-constructed-farm-wetlands.pdf

2.2 Swales



Swale on the Alconbury Brook, Cambs. Source: K.Paterson, EA

Natural Flood Management purpose

Swales are linear, shallow, vegetated drainage features that convey and store surface water and provide the opportunity for infiltration and water treatment by encouraging settlement.
They reduce runoff rates by slowing runoff flow.
They reduce volume of runoff by increasing the opportunity for infiltration and evaporation.
They trap sediment which can reduce the function of neighbouring watercourses and drainage systems.
They can be used to intercept, divert and direct water into storage areas.
They can be built in combination with bunded detention areas, or on their own to channel and redirect water flow that happens after heavy rain.
Easily incorporated into the landscape, the increased roughness of the vegetated channel helps to slow the flow of water. This can be reduced further by the introduction of check dams and berms across the swale.

Considerations

- The location of these solutions may well be suggested by the reaction of the landscape to heavy rainfall. Their design should be tailored to each location, working with natural pathways.

Method

Design of the swales should be site specific and take into account the contour of the surrounding land, the position in the landscape, and the soil type.

Agricultural benefits

Swales will collect surface runoff water . The collected water is conveyed to a storage area to infiltrate into the ground.
They help to reduce runoff and risk of soil erosion and water pollution.
Swales slow water flows during heavy rainfall and reduce downstream flooding.

Key locations

- Shallow slopes prone to runoff during flood events, not greater than 2 degrees.
- Areas where runoff with a heavy sediment load is known to compromise local drainage.

Swale at Feeringbury, Essex. Source: M. Butcher, EA.

Costs

Set up costs:	Maintenance costs:
Medium	Low

Funding

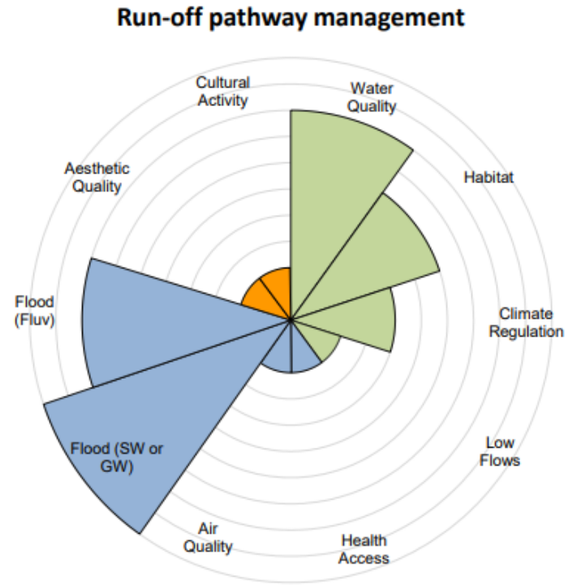
Various financial incentives available, see below for links to options and payment rates.

Level of maintenance required

Low:
Some vegetation control may be required.
Maintenance is increased by the addition of structures within the swale.
Removal of sediment and re-spreading to land will require a waste exemption licence from the Environment Agency (EA).

Benefits summary

Environmental	**Water quality improvement:** sediment deposition, reduced diffuse pollution **Habitat provision:** creation of habitats for a range of aquatic mammals, amphibians and invertebrates. **Climate regulation:** carbon sequestration **Low flow regulation:** permanent features provide storage areas for times of drought. They promote infiltration, enabling groundwater recharge.
Social	**Reduced risk of fluvial, surface water and groundwater flood:** Reduction in flood risk through water storage.
Cultural	**Aesthetic & cultural value:** Can provide recreation opportunities, aesthetic and health benefits



Swale on the Alconbury Brook, Cambs. Source: K.Paterson, EA.

Additional Information

https://www.gov.uk/countryside-stewardship-grants/swales-rp11
https://www.susdrain.org/delivering-suds/using-suds/suds-components/suds-components.html
https://www.gov.uk/government/publications/agricultural-transition-plan-2021-to-2024/technical-annex-the-combined-environmental-land-management-offer#species-recovery-and-management

2.3 Sediment traps and bunds

Field bund. Source: Norfolk Rivers Trust

Natural Flood Management purpose

Sediment traps target known overland flow pathways, they can disrupt and attenuate overland flow, slowing the time taken for the water to reach the channel and potentially reducing the flood peak. Bunds are created by excavating earth locally to create a mound, which act to halt a runoff pathway. Both reduce siltation of watercourses, by allowing sediment to drop out of suspension as well as slowing the flow of water.

Considerations

- Consent may be required to remove and spread sediment caught in a sediment trap.
- Sediment traps are not intended to treat wastewater or effluents.
- Sediment traps can also be used as a pre-treatment for water running into a temporary storage area.
- Earth bunds work most efficiently when located across known runoff pathways which appear following heavy rainfall or when the soil is saturated.
- Sediment traps can take many forms, but normally comprise an excavation located on a surface runoff pathway.
- Runoff enters the excavation and is detained there, allowing sediment to settle out before the runoff is discharged, usually via a gravel outlet.
- Sediment traps are unlikely to derive significant flooding benefits on their own. However, when used in conjunction with other runoff management features, they can help to control the release of sediment to the river network.

Agricultural benefits

- Runoff water is slowed, which allows sediment to be deposited and collected for reuse on farm.
- Settlement traps can be small or large to fit farm size and requirement.
- The creation of traps and bunds provides a barrier to prevent to excess nutrients reaching water courses.

Method

- Bund height should be created from compacted subsoil and should not exceed 1.3m.
- The slope of the sides should be less than 1 in 4 or gentler and vegetated. Where a bund is used to create a sediment trap (such as in a low corner of a field) the field side bank should be as gentle as possible, ideally no steeper than 1 in 20, to provide a filter strip function. Ensure access is provided for maintenance.
- The size will depend on runoff volumes to be intercepted; however, the greater the scale, the greater the removal efficiency.

Key locations

- Slopes prone to runoff during flood events.
- Areas where runoff with a heavy sediment load is an issue.
- Where runoff would otherwise enter a water-course

Level of maintenance required

Variable: Sediment traps will need to be regularly emptied – the frequency will depend on the area being drained and how much sediment is carried by the stream or ditch. Removal of sediment and respreading to land will require a waste exemption license from the Environment Agency (EA).

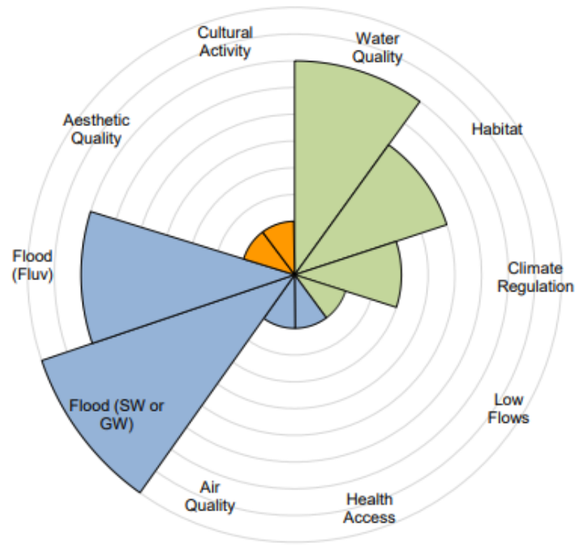
Costs

Set up costs:	Maintenance costs:
Low (depending upon scale)	Low

Funding

Various financial incentives available, see below for links to options and payment rates.

Run-off pathway management



Benefits summary

Environ-mental	**Water quality improvement:** sediment deposition, reduced diffuse pollution **Habitat provision:** creation of habitats for a range of aquatic mammals, amphibians and invertebrates, as well as farmland birds **Climate regulation:** carbon sequestration **Low flow regulation:** permanent features provide storage areas for times of drought. They promote infiltration, enabling groundwater
Social	**Reduced risk of fluvial, surface water and groundwater flood:** Reduction in flood risk through water storage.
Cultural	**Aesthetic & cultural value:** wetlands are valued as distinctive landscape features and can provide recreation opportunities, aesthetic and health benefits.

Sediment trap. Source: Norfolk Rivers Trust

Additional Information

https://www.gov.uk/countryside-stewardship-grants/sediment-ponds-and-traps-rp7
https://www.gov.uk/countryside-stewardship-grants/earth-banks-and-soil-bunds-rp9
https://www.gov.uk/government/publications/agricultural-transition-plan-2021-to-2024/technical-annex-the-combined-environmental-land-management-offer#species-recovery-and-management

2.4 In-channel leaky barriers/leaky debris dams

Leaky debris dam, Roxwell Brook, Essex.
Source: D.Tansley, Essex Wildlife Trust.

Natural Flood Management purpose

A network of in-channel barriers installed on a local scale can control channel flows. The dams are created to be slowly leaky, draining the trapped water once the flood period has passed. In-channel barriers could reduce the 1 in 100 year flood peak by 20%. Dams can be constructed so that floodwater spills onto the floodplain for additional temporary storage where conditions are suitable.

Key locations

- In-channel barriers are generally suited to smaller water courses and ditches throughout the catchment, where holding water back is not going to create additional problems.
- Steep woodland in the upper catchment, recommended to be implemented alongside runoff attenuation features; for example, understory planting.
- They can also be located within fields on overland flow pathways.

Considerations

- Avoid areas in close proximity to bridges and culverts to reduce blockage
- To ensure efficacy, many barriers are likely to be needed in a catchment. Their implementation will need careful planning to make sure that the overall pattern of flood flows is not altered, as this can cause flood peaks to coincide.
- Debris bundles can also be constructed in wooded areas to further roughen the surface of floodplain and trap overland flows.
- Local materials should be used where possible
- Use untreated wood where possible, however, tanalised timbers are acceptable.
- They can block fish passage at low flows, become blocked if positioned too close to the bed level.
- If bank scour is an issue, consider putting a notch in the top of the woody debris to allow water to pass over.
- When whole trunks, secured into place with stakes and wires, are used they are often known as large woody dams.
- The dams are set above normal stream level, so only flood flows are blocked and they don't interfere with normal flow conveyance.
- Water is stored within the channel behind constructed dams, reducing the downstream flood peak by slowing the flow.
- Should not be located just downstream of a land drain

Agricultural benefits

Dams can successfully reduce localised flooding within the farm holding.

Sediment trapped behind each structure is nutrient rich and can be reused on the farm.

Method

Large woody dams are created by laying two large tree trunks in a cross formation across the channel to rest safely on both banks, wedged in position. Smaller timbers can be wedged in place between the larger ones.

Leaky dams are constructed by securing a support across the channel and securing slats, either horizontally or vertically to form a discontinuous barrier.

Varying the height of the timber above normal river flow will determine the rate and volume of retained floodwater. This will also permit fish passage.

A permit may be needed from the relevant RMA, please discuss prior to installation.

Funding

Various financial incentives available, see links to options and payment rates.

Costs

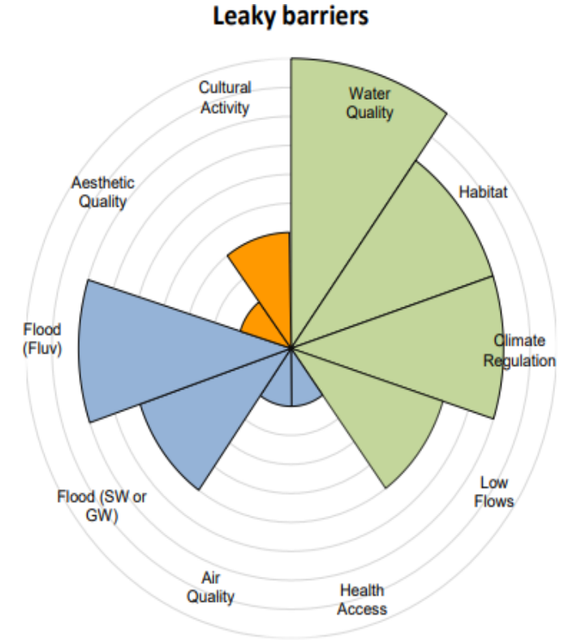
Set up costs:	Maintenance costs:
Low	Low

Benefits summary

Environmental	**Water quality improvement:** major benefit for sediment retention and nutrient reduction through phosphate and nitrate uptake. **Habitat provision:** Improved habitat diversity by creating pools and varied channel morphology, support fish and macroinvertebrates. **Climate regulation:** increased resilience to climate change by regulating temperature and water level. **Low flows:** Can divert low and high flows, providing respite for organisms from flooding and drought events.
Social	**Reduced risk of fluvial, surface water and groundwater flood:** create additional water storage capacity and roughness, which can capture flood flows and slow it.

Level of maintenance required

Medium Large woody dams will need periodic checking to ensure the logs are still wedged in the right position. They may also require periodic clearance of debris to prevent complete blockage and overflow of water.



Leaky dam, Thaxted, Essex.
Source: N.Shearer. EA

Additional Information

https://www.gov.uk/countryside-stewardship-grants/rp32-small-leaky-woody-dams
https://www.gov.uk/countryside-stewardship-grants/rp33-large-leaky-woody-dams
https://www.gov.uk/countryside-stewardship-grants/check-dams-rp12
https://www.gov.uk/government/publications/agricultural-transition-plan-2021-to-2024/technical-annex-the-combined-environmental-land-management-offer#species-recovery-and-management

2.5 Flow deflectors

Large woody debris, River Tat, Norfolk. Source: A.Thurtle, WMA.

Natural Flood Management purpose

Large woody debris when carefully placed can be used to slow and direct water into temporary storage areas. When large woody debris or flow deflectors are placed immediately downstream of sections of lowered bank it can be an effective technique in helping to slow and lessen the flood peak as it travels downstream by encouraging flood flows out of bank and into the floodplain. Can be used as a technique to help reduce bank erosion, where sited strategically to deflect flows

Key locations

- Disconnected floodplains
- Streams lined with woodland
- Drainage ditches
- Uniform, habitat poor channels
- Areas adjacent to flood storage areas
- Lengths of bank requiring erosion protection

Method

- Occupy up to 2/3 of the channel width to cause narrowing and backing up of water.
- Place woody debris in channel at an angle between 30^0 and 45^0 to the bank.
- Secure firmly in the bank and channel to increase stability and ensure it's not washed away during peak flows
- To ensure maximum longevity, position woody material in a downstream direction (to go with the flow) rather than have the full force of the flow pushing against them.
- Fallen trees can be left in situ (providing it's not causing a flood risk).
- Trees can be dropped and hinged so that they remain securely attached in the river bank.

Considerations

- Avoid areas in close proximity to bridges, culverts and gauging stations to reduce blockage and backing-up of water levels where unwanted.
- Woody dams, deflectors and diverters can increase scour or erosion. In most cases this will stabilise in time, and further mitigation can be incorporated
- Local materials should be used where possible
- Use untreated wood where possible, however, tanalised timbers are acceptable.
- A permit may be needed from the relevant RMA, please discuss prior to installation.

Agricultural benefits

Large woody debris when used correctly can help narrow the channel, increase flow and keep silts mobilised. This can help where channels become choked with vegetation.

Mobilised silts are deposited where flood-flows are able to connect with their floodplains, providing beneficial nutrients to the soil.

Costs

Set up costs:	Maintenance costs:
Low	Low

Funding

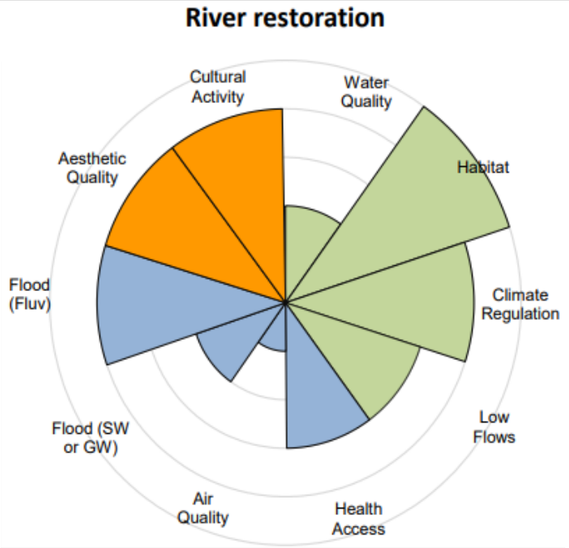
Funding may be available where the addition of large woody debris acts to improve habitat. Contact the EA for further information.

Level of maintenance required

Minimal maintenance may be required to ensure a proportion of the channel is kept clear for conveyance or access purposes.

Benefits summary

Environmental	**Water quality, habitat provision, climate regulation, low flows. In-channel habitat improvements beneficial to all biodiversity.**
Social	**Reduced risk of surface water, groundwater and fluvial flooding.** **Physical/mental health benefits associated with green space.**
Cultural	**Aesthetic and cultural value**. Benefits to recreation and tourism though improvements to fisheries.



Additional Information

https://www.woodlandtrust.org.uk/publications/2016/08/natural-flood-management-guidance/
https://www.wildtrout.org/assets/files/library/Woody_Debris_Apr2012_WEB.pdf

Large woody debris, River Tat, Norfolk. Source: A.Thurtle, WMA.

Floodplain restoration

While natural flood management measures associated with land management seek to reduce flood water generation, natural flood management measures in the river channel or on its bank or floodplain seek to improve the ability of rivers to manage those floodwaters.

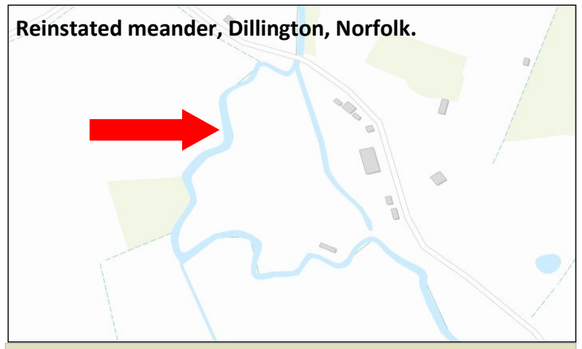
In the past, rivers have been managed to increase the land available for agriculture (by straightening the channel) and to protect land from flooding (by building embankments).

Restoring the connection between a river and its floodplain provides a valuable contribution to natural flood management, allowing floodwater to spill naturally onto land to provide significant flood storage, reducing risk to lives and property further downstream. River and floodplain restoration encompasses a range of different techniques which are often used in conjunction. They include restoring meanders, removal, lowering or setting back of flood banks. These can provide flood risk benefits as well as ecological ones through creation of wetlands and better connected habitat for breeding and wintering waders, and wet woodland.

Initial advice as to a site's suitability can be given by local Environment Agency (EA) staff, early contact is highly recommended.

River restoration and floodplain reconnection at Pudding Norton, Norfolk. Source: Norfolk Rivers Trust

3.1 Restoring Meanders



Reinstated meander, Dillington, Norfolk.

Natural Flood Management purpose

Restoring the shape (morphology) of the watercourse by re-creating meanders will increase the time taken for the floodwater to flow downstream by making it go further. This slows the flow and allows the river to carry a greater volume of water before it spills out of its course.

Key locations

Re-meandering can be used in locations where the watercourse has been previously straightened, particularly in the mid-lower reaches. Remnant meanders can often be identified using aerial photos.

Costs

Set up costs:	Maintenance costs:
High	Low

Funding

Specialist advice on funding is needed. Early engagement with EA recommended .

Agricultural benefits

Allowing more natural lower energy flooding reduces risk of bank and embankment failure. The river can drain back into the channel rapidly as levels fall rather than water being trapped behind embankments. Removes need for maintenance of artificial engineering works . Provides rich wildlife habitat and better fisheries.

Method

Dimensions are entirely site dependent and will need detailed specialist advice.

Considerations

Restoration always needs to be carefully planned by specialist water engineers and ecologists as it will influence the behaviour of the flow of floodwater over a wide area. It may need detailed modelling and design, and will require planning and other permissions and consents. It is likely to be high cost and need specialist contractors.

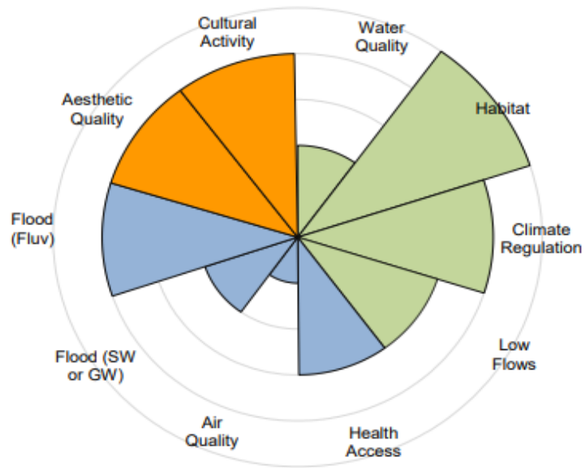
Level of maintenance required

Low: None likely once the initial work is done.

Benefits summary

Environmental	**Water quality improvement**, through restoration of the river's natural cleansing ability **Habitat provision**: Improved resilience for the whole river ecosystem **Low flow regulation:** Can divert low and high flows, providing respite for organisms from flooding and drought events.
Social	**Reduced risk of fluvial, surface water and groundwater flood:** can restore connectivity between groundwater and surface water. Can reduce flood peak magnitude through improved connectivity of the river to its floodplain.
Cultural	**Aesthetic and recreational value:** from restoration of the landscape to a more natural form .

River restoration



3.2 Floodplain reconnection

Floodbank lowering, Buxton, Norfolk. Source: T. Jones, NRIDB.

Natural Flood Management purpose

Floodplain restoration aims to restore the hydrological connection between rivers and floodplains so that floodwaters inundate the floodplains and store water during times of high flows. This can involve removing flood embankments and other barriers to floodplain

Key locations

Principally, where floodplains are wide and flat and there is no risk to property or infrastructure, through reconnecting it.
Areas where the river/stream/etc has been disconnected from the floodplain e.g. by an earth

Method

Floodplain reconnection aims to reconnect the river with its floodplain using a wide range of techniques. Choice of technique is dependent upon the type and characteristics of the water body in which it is going to be applied. Techniques include:

- River restoration
- Flow deflectors/large woody debris to encourage water up and out onto the floodplain.
- Reconnecting old side channels
- Breaching of existing earth bunds
- Improving the operation of flap valves within embankments
- Lowering of flood defences
- Connecting the river to floodplain wetland
- Removing or modifying pumping stations
- Breaching embankments as part of habitat creation projects.

Dimensions are entirely site dependent and will need detailed specialist advice.
Pre-works assessments and surveys will be required to ensure that works do not increase flood risk (for example, an embankment may be holding water back during a flood event and removal could increase flood risk).

Agricultural benefits

- Allowing more natural lower energy flooding reduces risk of bank and embankment failure.
- The river can drain back into the channel rapidly as levels fall rather than water being trapped behind embankments.
- Removes need for maintenance of artificial engineering works.
- Provides rich wildlife habitat and better fisheries.

Considerations

- Speak to your relevant RMA early on to understand what permits may be needed prior to starting works.
- Permission will be needed from landowner on both banks where restoration works are planned.

Costs

Set up costs:	Maintenance costs:
High	Low

Funding

Specialist advice on funding is needed. EA funding may be possible. See link s overleaf.

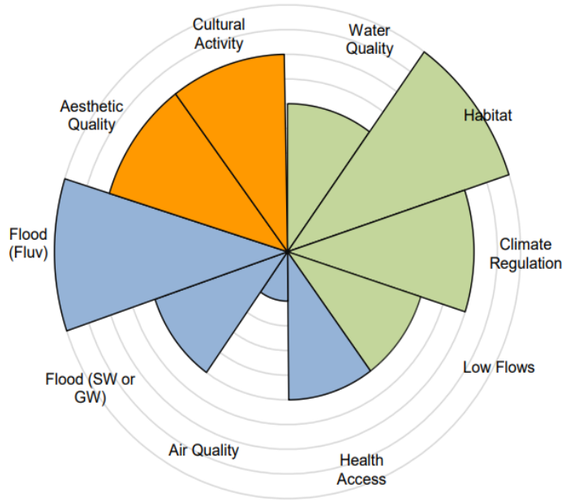
Benefits summary

Environmental	**Water quality improvement**, through restoration of the river's natural cleansing ability **Habitat provision**: Improved resilience for the whole river ecosystem **Low flow regulation:** Can divert low and high flows, providing respite for organisms from flooding and drought events.
Social	**Reduced risk of fluvial, surface water and groundwater flood:** can restore connectivity between groundwater and surface water. Can reduce flood peak magnitude through improved connectivity of the river to its floodplain.
Cultural	**Aesthetic and recreational value:** from restoration of the landscape to a more natural form**.**

Level of maintenance required

Minimal maintenance required after initial works are complete.

River floodplain restoration



Floodplain reconnection, Marlingford, Norfolk. Source: H. George, EA.

Additional Information

https://www.gov.uk/countryside-stewardship-grants/making-space-for-water-sw12
https://www.gov.uk/countryside-stewardship-grants/sw16-flood-mitigation-on-permanent-grassland
https://www.gov.uk/countryside-stewardship-grants/management-of-wet-grassland-for-breeding-waders-gs9
https://www.therrc.co.uk/guidance
https://www.edp24.co.uk/news/business/20860460.historic-meander-reconnected-upper-wensum-river-restoration/
https://www.gov.uk/government/publications/agricultural-transition-plan-2021-to-2024/technical-annex-the-combined-environmental-land-management-offer#species-recovery-and-management

3.3 Wetland restoration/creation

Constructed wetland, River Ingol.
Source: Norfolk Rivers Trust

Natural Flood Management purpose

Whilst providing important habitat for an array of biodiversity, wetlands also provide:

- Storage to intercept water during periods of flooding. This is mainly on the surface and will flow back into the river later, evaporate or recharge groundwater.
- Slowing of flood-waters making their way down stream, resulting in a reduced flood peak. Wetlands and surrounding land covered in rough vegetation will add friction and slow down flow pathways.
- Filtration and interception of sediments, reducing the need for sediment management downstream.

Key locations

- Catchment-wide.
- Can be large or small
- Identify low lying areas that always sit wet and enhance/ work with these.

Method

- Will be site specific
- Where new wetlands are being created, this should be done with the provision of additional storage capacity in mind.
- Wetlands take many forms but are usually areas of land permanently or seasonally covered by shallow water.

Wetlands can be:

- Shallow lakes, ponds, rivers, streams and ditches
- Floodplain meadows and wet grasslands
- Estuaries and mudflats
- Peatlands, marshes, fens and wet woodland

They can be restored where they've deteriorated or been lost and can be newly created where suitable.

Agricultural benefits

- Reduction in soil loss.
- Effective removal of water contaminants including suspended sediments and pathogens.
- Retention of year-round water.

Considerations

- Requires land
- Must be located so as not to increase flood risk to people and properties.

Costs

Set up costs:	Maintenance costs:
Medium to High	Low

Level of maintenance required

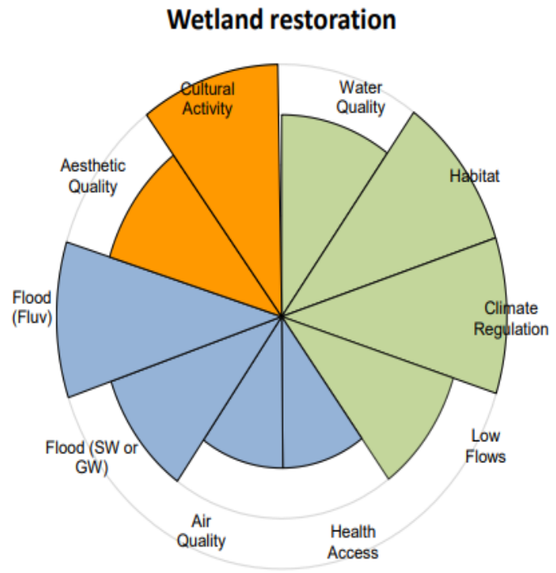
Minimal maintenance required after initial works are complete.

Funding

Funding may be available through EA/partners. Various financial incentives available, see links to options and payment rates.

Benefits summary

Environmental	**Water quality:** from deposition of sediment and nutrients), **Habitat provision:** for water based wildlife. **Climate regulation:** wetlands can act as a carbon sink . **Low flow regulation:** groundwater recharge .
Social	**Reduced risk of fluvial, surface water and groundwater flood:** Can reduce flood peak magnitude through provision of storage.
Cultural	**Aesthetic and recreational value:** from restoration of the landscape to a more natural form



Additional information

https://www.gov.uk/countryside-stewardship-grants/sediment-ponds-and-traps-rp7
https://www.gov.uk/countryside-stewardship-grants/creation-of-scrapes-and-gutters-wn2
https://www.gov.uk/countryside-stewardship-grants/creation-of-wet-grassland-for-wintering-waders-and-wildfowl-gs12
https://www.gov.uk/countryside-stewardship-grants/sw16-flood-mitigation-on-permanent-grassland
https://www.gov.uk/countryside-stewardship-grants/making-space-for-water-sw12
https://freshwaterhabitats.org.uk/wp-content/uploads/2013/09/WETLAND.pdf
https://freshwaterhabitats.org.uk/projects/million-ponds/pond-creation-toolkit/
https://freshwaterhabitats.org.uk/wp-content/uploads/2013/09/FLOODPLAIN.pdf
https://community.rspb.org.uk/ourwork/b/martinharper/posts/the-halvergate-marshes-freshwater-project-working-for-farmers-wildlife-and-the-climate
https://www.gov.uk/government/publications/agricultural-transition-plan-2021-to-2024/technical-annex-the-combined-environmental-land-management-offer#species-recovery-and-management

Halvergate Marshes Water Level Management Improvement Scheme, Norfolk.
Source: Broads Internal Drainage Board

3.4 Beavers

Beaver, Great Stour, Kent. Source: B. Morris, EA.

Eurasian beavers (*Castor fiber*) are a European protected species in England. They are a keystone species and can assist in flood defence, drought mitigation, improve water quality and boost wildlife populations and biodiversity.

Natural Flood Management purpose

Beavers can help to reduce the risk of flooding through building upstream dams in small watercourses. They do this to create pools in which they can move around, hide from predators and store food. The dams are temporary structures and mirror that of leaky dams. Both leaky dams and beaver dams allow water to flow through, at a much slower rate, reducing the volume of water flowing downstream to vulnerable, at risk communities during periods of heavy rainfall. They help to reduce the risk of flash-flooding downstream, reduce erosion and improve water quality by holding silt and intercepting acidic and agricultural

Drought mitigation purpose

Beavers can also help provide drought mitigation and climate-change adaptation through provision of the wetland habitat they create. The same slowing effect that occurs during times of flood can help keep rivers and their aquatic plants and animals alive and cooler in times of drought.

Key locations

Where the habitat is suitable and the surrounding landowners are willing.

Considerations

- Currently in England, release of beavers is only permitted into fenced enclosures under a Natural England licence.
- A project plan, justification and management plan will be required as part of a licence application.
- Engagement with neighbouring landowners is advisable to make sure they are aware of a project of this nature and what any impacts to their land maybe.

Method

- As a first step it is recommended to contact The Beaver Trust to help determine whether a proposal is worth taking forward.
- A Feasibility Study will be required to fully consider the location, habitat suitability and potential impacts to existing habitat and species of an enclosure.
- Justification as to why the release of beavers into an enclosure at a given location will be sought.
- A management plan will be required.
- Fish passage will need to be considered, are migratory species present? what will the impact be? is any mitigation required?
- Flood risk modelling may be required.

Fencing has to be installed to a specification specific to the site that limits the likelihood of beaver escapement and may include:

* Beaver-proof metal
* Skirt dug into the ground to prevent burrowing under
* Overhang to prevent climbing over

- Twice-weekly inspections to check for signs of damage.

Costs

The cost of a feasibility study, fencing the enclosure area, specialist surveys, licencing, sourcing of a pair of beavers and ongoing management/maintenance are the main costs to be aware of.

Benefits summary

See wetland construction and leaky debris dams.

Watercourse at Spains Hall, Essex, pre-beavers. Source: Atkins

Wetland created at Spains Hall, Essex, post-beavers. Source: Atkins

Agricultural benefits

Making space for beavers within a farming landscape can result in land adjacent to enclosures remaining wet, lush and green, even in times of drought. This may mean cattle have long green grass even in the driest of summers. New beaver ponds could also be used to provide drinking water for livestock and irrigation for crops. In addition, the storage of water can help remove phosphate and nitrogen from the system and help with groundwater recharge.

A parched arable landscape in the thick of drought, adjacent to lush, wet, green floodplain remaining wet due to beaver activity. Source: Clinton Devon Estates .

Level of maintenance required

Maintenance of the fencing around the enclosure will be required. Repairs may be necessary as well as a plan should escape occur. It may be necessary for dams to be removed if they're in a location that compromises flood risk.

Funding

Funding is available for the fencing of beaver enclosures.
https://www.gov.uk/countryside-stewardship-grants/bc3-crop-protection-fencing-mesh-and-wire-for-permanent-crops

Did you know? A study in Devon has revealed that crop damage caused by beavers equates to no more than that caused by deer and pigeons.

Additional Information

https://beavertrust.org/our-work/beaver-management/

https://beavertrust.org/beaver-basics/case-studies/

https://www.spainshallestate.co.uk/nfm_beavers

https://norfolkriverstrust.org/beavers/

https://clintondevon.com/drone-shots-show-how-beavers-are-defying-devon-drought/

Coastal NFM 4.1 Sand dune regeneration

Sand dunes, Old Hunstanton, Norfolk. Source: H. George, EA.

Natural Flood Management purpose

Sand dunes are a vital element of coastal flood defences, they provide a natural defence against coastal erosion and flooding. The marram grass vegetation that dominates sand dunes acts as an important natural buffer to help absorb wave energy. This natural barrier helps to protect the coastal communities that sit behind them.
Dunes form above the high tide level, trapping wind-blown sand, which over time accumulates and increases the height and width of the dunes. As the dunes increase in size, more habitat is created in which more plants and ecosystems can live and with that provide a better buffer against flooding.
Dunes also act as reservoirs of sand to nourish beaches during storms. Through this function they form a buffer zone, protecting structures or cliffs behind from direct wave attack and erosion.
The flood and coastal defence function of dunes varies in significance around the coastline with dunes in North and East Norfolk forming an important flood barrier to extensive low-lying agriculture areas.

Given their location, sand dunes are dynamic and respond to changing conditions. However, if more erosion of the dunes occurs quicker than the sand can be replaced, it causes damage to the dunes and can increase the risk of flooding behind. It is therefore important to protect sand dunes from erosion and allow the vegetation to establish and the dunes to build up.

Method

- Providing designated fenced access points through dunes to help limit erosion and protect vegetation from footfall
- Fencing on the seaward side of the dunes to encourage sediment deposition
- Planting of sand dune species where bare sand occurs in the zone above high tide level.

The three main techniques to help protect the dunes, trap sediment, and prevent excess erosion are: fencing, planting and thatching.

Dragon's teeth fencing. Holme next the Sea. Norfolk. Source: H. George, EA.

Dune fencing involves the construction of fences along the seaward face of the dune to reduce wind speed on the surface and encourage deposition of transported sediment. At Holme next the Sea in North Norfolk fencing was placed in a zig-zag formation to trap sand and encourage dune development and help provide protection to freshwater designated habitat and properties behind. Can be used in combination with other measures such as thatching and grass seed planting, and to prevent public (and animal) access.
Can be used to promote foredune growth or repair sections of dunes and blowouts.
Arrangement of fences can be altered to achieve different results, but success will depend on the individual site.

Re-planted marram grass on reprofiled sand dunes, Eccles, Norfolk. Source: H. George, EA.

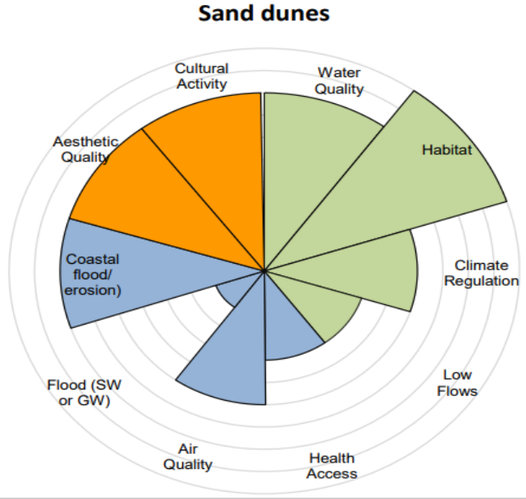
Dune planting encourages dune growth by trapping and stabilising blown sand, thereby increasing the buffer zone. Typically marram grass, lyme grass or couch grass are used. It is best to transplant established dune grasses from a nearby site and is likely to take two to three years before transplants begin to thrive and spread. The vegetation and root network physically trap and hold sand in place. May require some pre-works such as reprofiling to create a more stable dune face; the impact of and ability to carry out such works would need to be considered. Can be used in combination with other measures such as thatching, fencing and beach nourishment.

Brushwood bundles used in Thatching. Source: Salixrw.com

Dune thatching is a technique that involves placing organic materials such as branches, straw or reed bundles on the exposed face of dunes and blowouts to stabilise sand and encourage accretion.
Often used in combination with dune grass planting.
Typically used to repair blowouts. It is particularly effective where the amount of wind-blown sand is considerable. Can retain shape of original dune as brushwood becomes buried.

Benefits summary

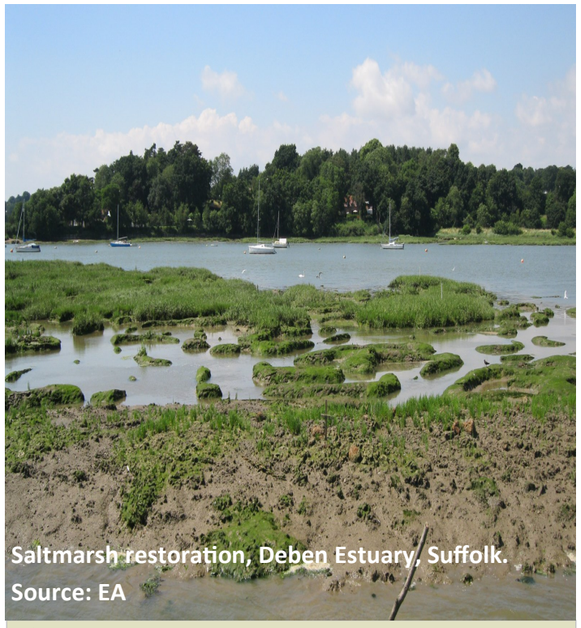
Environmental	**Habitat provision:** Sand dunes provide a highly diverse mix of habitats and services. **Water quality:** Sand dunes are effective at improving water quality, filtering nutrients before they reach the marine environment **Climate regulation:** As dunes are an early successional habitat, carbon accumulation rates are high
Social	Recreation in coastal areas provides physical health benefits **Coastal/flood erosion:** Dune systems function as barriers to coastal flooding.
Cultural	Sand dunes are very important for their aesthetic and recreational value.



Additional information

https://www.gov.uk/countryside-stewardship-grants/management-of-coastal-sand-dunes-and-vegetated-shingle-ct1
https://www.gov.uk/countryside-stewardship-grants/creation-of-coastal-sand-dunes-and-vegetated-shingle-on-arable-land-and-improved-grassland-ct2
https://www.gov.uk/government/publications/agricultural-transition-plan-2021-to-2024/technical-annex-the-combined-environmental-land-management-offer#species-recovery-and-management

4.2 Saltmarsh and mudflat restoration



Saltmarsh restoration, Deben Estuary, Suffolk. Source: EA

Natural Flood Management purpose

- **Wave attenuation**: waves break in shallow coastal water, and in so doing expend energy which drives erosion and sediment transport. Consequently, in areas with wide intertidal flats such as healthy saltmarsh complexes, wave breaking and resulting erosion occurs away from critical flood defences and vulnerable receptors. By inducing breaking further offshore, saltmarsh also reduces the likelihood of waves and swash (overtopping defences).
- **Surge attenuation:** particularly extensive areas of saltmarsh can reduce the impact of storm surges (the increase in water level caused by low pressure storm systems) by increasing the friction acting on the surge as it propagates into an estuary. This mechanism is broadly similar to that which attenuates wave energy, albeit at a much larger scale. Restoration of saltmarsh via managed realignment or regulated tidal exchange in particular can reduce the impact of storm surges by reshaping the intertidal zone and creating space to accommodate larger volumes of water. This can have the effect of lowering peak water levels reducing the risk of flooding.
- **Sediment trapping:** naturally functioning saltmarsh has an inbuilt capacity to trap and retain sediment in order to maintain an equilibrium elevation relative to the tidal frame (the vertical envelope between MHWS and MLWS). This makes it resilient to erosion, and capable of natural unaided recovery following erosive events such as storms. Saltmarsh restoration is a prime example of a 'nature-based solution', offering high potential to reduce flooding and coastal erosion, increase carbon sequestration, as well as a range of other ecosystem services.

Key locations

Saltmarsh and mudflats are generally located together; with mudflats fronting saltmarsh. To form these habitats, fine grained sediments (silts and clays) need to settle out of the water column, which will only occur at very low water speeds and in sheltered areas. The four elements to allow colonisation of a mudflat and growth of saltmarsh are:

- relatively stable (slowly accreting) area of sediment exposed to the air for more time than it is inundated by the tide;
- suitable suspended sediments present in the water during the inundation period;
- sufficiently low water speeds to allow some of this sediment to settle out;
- a supply of appropriate seeds or propagules to establish vegetation cover. For initial colonisation of mudflat, it is important that pioneer species seeds are present. It has been shown that there should be sufficient suspended sediment in the water to allow an accretion rate of 3-10mm per year.

Managed realignment is a planned breach or relocation of sea defences further inland, creating sustainable, environmentally beneficial intertidal habitat in the form of mud flats and salt marshes.

Method

Brushwood fascines/groynes: Small wooden posts erected in parallel rows and in-filled with brushwood to create a small fence. Other materials can be used but brushwood has been found to be the most durable. The best orientation is generally at right angles to the foreshore .

Polders: Brushwood fences or fascines are erected that enclose a width of mature marsh with a similar sized seaward extent of mudflat. Ditches are dug to collect deposited sediment, which is then piled onto banks between the ditches.

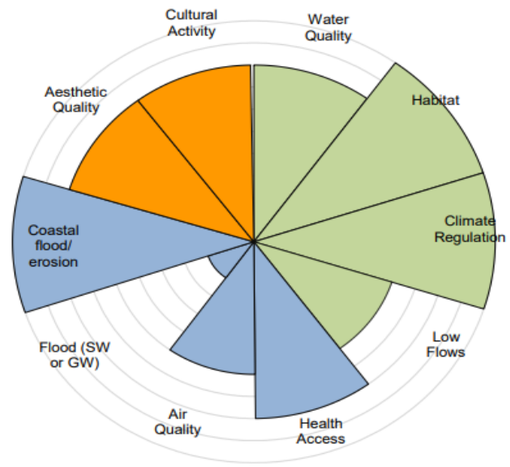
Saltmarsh can be left to naturally colonise the mudflats. However, unless there are good natural sources of local seeds, planting or sowing will be needed. Planting has generally been shown to be more effective than sowing. It is generally better to increase the extent or facilitate the relative stability of existing saltmarsh, rather than attempt to establish this habitat in new areas where it has not been present historically.

Saltmarsh restoration using brushwood fences, Waldringfield, Suffolk. Source: EA.

Benefits summary

Environmental	**Habitat provision:** Saltmarsh and mudflats support a diverse range of species. **Water quality:** Removal and filtration of nutrients before they reach the marine environment **Climate regulation:** Water absorbs heat and buffers the temperature of coasts, and the vegetation of saltmarshes attenuates wind power. They are also significant carbon sinks
Social	**Coastal/flood erosion:** Saltmarshes and mudflats attenuate waves. The presence of saltmarsh vegetation encourages the trapping of sediment and reduces its erosion. **Air quality:** Saltmarshes and mudflats are significant carbon sinks.
Cultural	Saltmarshes are wild places, creating iconic landscapes depicted in art and literature.

Saltmarsh and mudflat management and restoration and managed realignment



https://www.gov.uk/countryside-stewardship-grants/management-of-coastal-saltmarsh-ct3
https://www.gov.uk/countryside-stewardship-grants/creation-of-inter-tidal-and-saline-habitat-on-arable-land-ct4
https://www.gov.uk/countryside-stewardship-grants/creation-of-inter-tidal-and-saline-habitat-by-non-intervention-ct5
https://www.gov.uk/countryside-stewardship-grants/creation-of-inter-tidal-and-saline-habitat-on-intensive-grassland-ct7
https://catchmentbasedapproach.org/learn/saltmarsh-restoration-handbook/
https://www.gov.uk/government/publications/agricultural-transition-plan-2021-to-2024/technical-annex-the-combined-environmental-land-management-offer#species-recovery-and-management

4.3 Beach nourishment

Bacton to Walcott Sandscaping Scheme, Norfolk. Source: Van Oord.

Natural Flood Management purpose

Beach nourishment – also known as recharge, renourishment or replenishment – is the process of adding material to the shoreline where it will be incorporated into a beach system by natural processes to help retain the standard of protection from flood risk for a section of coast.

Beaches are recognised as providing the most effective form of coastal defence, acting to dissipate wave energy and adapt naturally to changing wave and tidal conditions.

However, beaches can only perform this function if they are of sufficient width and level. Many natural beaches have reduced in volume over time and therefore nourishment is performed to improve or restore beaches and their coastal defence function.

Nourishment through the import of sediment, achieves Flood and Coastal Risk Management objectives while working within the principles of Working With Natural Processes.

Key locations

Where beach material has been depleted such that it poses an increased risk of coastal flooding to people, properties, designated habitat and nationally important infrastructure.

Method

Nourishment is carried out at a range of scales from small schemes involving <10,000m3 of sediment to the mega-nourishment projects, e.g. the Sand Engine in the Netherlands, which has involved a total sediment volume of 21 million m3.

Placement of the material also varies from upper beach (and dune) to shoreface. Traditionally in the UK, nourishment has been added to the mid to upper beach to build a larger and wider beach crest, as part of providing a required Standard of Protection.

Another method, more commonly used in the Netherlands than in the UK, involves the placement of nourishment material along the shoreface and

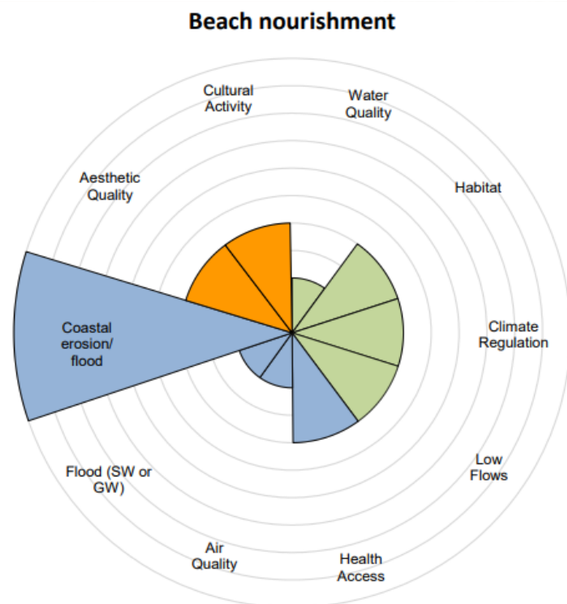
Bacton to Walcott Sand-scaping Scheme

In 2019, approximately 1.8 million cubic metres of sand was placed on the beaches between Bacton Gas Terminal and Walcott, in North Norfolk. As a result, the beaches have been transformed with significant increases made to both height and width. The scheme was developed following the devastating impacts of the 2013 North Sea Surge. The surge damaged and flooded homes and businesses and saw the loss of up to 10 metres of cliff at the Gas Terminal. Based on a Dutch concept, sandscaping sought to provide natural protection by improving beach levels that absorb the sea forces before they reach the cliff and defences. The scheme protects Bacton Gas Terminal, which processes up to one-third of the UK gas demand alongside improved erosion and flood protection to Bacton and Walcott.

Bacton to Walcott Sandscaping Scheme, Norfolk. Source: North Norfolk District Council.

Benefits summary

Environmental	**Habitat provision:** can enhance shorebird nesting areas and habitat **Water quality:** can cause short-term negative impacts e.g. turbidity and suspended solids. **Climate regulation:** Beach nourishment can help areas adapt to sea level rise due to climate change.
Social	**Coastal/flood erosion:** effective form of sea defence, dissipating wave energy and adapting naturally to changing conditions **Health access:** beaches encourage physical activity and psychological benefits
Cultural	Aesthetics: beaches are highly valued landscapes.



https://www.north-norfolk.gov.uk/sandscaping
https://www.royalhaskoningdhv.com/en/projects/a-uk-first-sandscaping-building-with-nature-in-bacton-norfolk
https://www.vanoord.com/en/updates/second-sand-motor-successfully-completed/

Consents and contacts

Some interventions may require consent prior to construction. It is recommended that you speak to your local Environment Agency Natural Flood Management Advisors **in the first instance** to help work out what types of consent may be required: helen.george@environment-agency.gov.uk or karen.paterson@environment-agency.gov.uk

Permits for work on watercourses and floodplains

If you're considering works that are on or nearby to a watercourse (river, stream, ditch, drain, culvert, dyke) you must first contact the relevant Risk Management Authority (RMA) to find out what permissions are required before you start. The RMA depends on what type of watercourse you're considering works on:

If it's a **Main River** (within 8m of the main river or within 16m if coastal), a Flood Risk Activity Permit from the Environment Agency may be required. See 'Main River map' https://www.arcgis.com/apps/webappviewer/index.html?id=17cd53dfc524433980cc333726a56386
For further permitting advice see, https://www.gov.uk/guidance/flood-risk-activities-environmental-permits or contact PSO.Eastanglia@environment-agency.gov.uk.

If it's an **Internal drainage board (IDB) arterial watercourse** (within 9m), a Land Drainage Consent may be required from the relevant board which can be checked here: https://www.ada.org.uk/idb-map/ where contact detail for further advice can also be found.

For **any other watercourse**, contact your Lead Local Flood Authority (either unitary authorities or county councils) as you may require Ordinary Watercourse Consent for works in the channel.

Areas with protected status

Interventions that are proposed to be undertaken on land with protected status such as Sites of Special Scientific Interest (SSSI), Special Areas of Conservation (SAC) and Special Protection Areas (SPA) will require Natural England consent. Interventions on SAC or SPA land will also require a habitat regulations assessment from Natural England. It is possible to find out whether your site has protected status by searching online using the website www.magic.gov.uk.

Scheduled Monuments

Scheduled Monuments Consent will also be required for intervention measures proposed to be undertaken on or near to Scheduled Monuments. It is possible to find out whether your site has protected status by searching online using the website www.magic.gov.uk or by contacting Historic England. Historic England www.historicengland.org.uk

Planning Consent

Planning permission may be required may be required for larger schemes, a discussion about proposed works should be held with the local planning authority (County Council or National Park Authority).

New woodlands

An Environmental Impact Assessment (EIA) may be required if more than 2ha of woodland planting is grant funded from sources other than the national agri-environment schemes. Contact the Forestry Commission for further information and support: adminhub.buckshornoak@forestrycommission.gov.uk

Local Lead Flood Authorities (LLFA's):

Norfolk County Council: water.managment@norfolk.gov.uk
Suffolk County Council: floods@suffolk.gov.uk
Essex County council: floods@essex.gov.uk
Cambridgeshire County Council: floodandwater@cambridgeshire.gov.uk
Bedford Borough Council: floodrisk@bedford.gov.uk
Central Bedfordhsire Council: floodrisk@centralbedfordshire.gov.uk
Milton Keynes City Council: llfa@milton-keynes.gov.uk
Buckinghamshire County Council: floodmanagement@buckinghamshire.gov.uk
West Northamptonshire Council: floodandwater@northamptonshire.gov.uk
Hertfordshire County Council: floodandwatermanagement@hertfordshire.gov.uk

Help and advice:

NFM Coordinator Anglian Region: helen.george@environment-agency.gov.uk
NFM Advisor Cambridgeshire, Bedfordshire & West Norfolk: karen.paterson@environment-agency.gov.uk
Catchment Sensitive Farming advice: csf.northanglia@naturalengland.org.uk
Norfolk Rivers Trust: info@norfolkriverstrust.org
Essex and Suffolk Rivers Trust: info@essexsuffolkriverstrust.org
Great Ouse Rivers Trust: https://www.greatouseriverstrust.org
River Waveney Trust: info@riverwaveneytrust.org
Norfolk Farming & Wildlife Advisory Group: advice@norfolkfwag.co.uk
Suffolk Farming & Wildlife Advisory Group: info@suffolkfwag.co.uk
East (Cambs, Essex, Herts, Beds, Northants) Farming & Wildlife Advisory Group: hello@fwageast.org.uk
National Trust: mee.customerenquiries@nationaltrust.org.uk
Woodland Trust: EasternClaylands@woodlandtrust.org.uk
RSPB: eastcoastwetlands@rspb.org.uk
Beaver licencing info: beaverlicence@naturalengland.org.uk
Water Resources East: https://wre.org.uk/

Further reading

Working With Natural Processes Evidence Directory (EA) https://www.gov.uk/flood-and-coastal-erosion-risk-management-research-reports/working-with-natural-processes-to-reduce-flood-risk

Natural Flood Management Handbook (2015), Scottish Environment Protection Agency (SEPA) www.sepa.org.uk/media/163560/sepa-natural-flood-management-handbook1.pdf

Runoff Attenuation Features (2011), Newcastle University/Environment Agency (EA) https://research.ncl.ac.uk/proactive/belford/papers/Runoff_Attenuation_Features_Handbook_final.pdf

Ciria Natural Flood Management Manual: https://www.ciria.org/ItemDetail?iProductCode=C802F&Category=FREEPUBS&WebsiteKey=a054c7b1-c241-4dd4-9ec1-38afd4a55683

Catchment Based Approach (CABA) https://catchmentbasedapproach.org/learn/what-is-natural-flood-management/

Broadland Futures Initiative: https://www.broads-authority.gov.uk/looking-after/climate-change/broadland-futures-initiative

Restoring Meadow, Marsh and Reef (ReMeMaRe): https://ecsa.international/reach/restoring-meadow-marsh-and-reef-rememare

Local Nature Recovery Strategies: https://www.gov.uk/government/publications/local-nature-recovery-strategies/local-nature-recovery-strategies

SFI 2024: https://www.gov.uk/government/publications/agricultural-transition-plan-2021-to-2024/technical-annex-the-combined-environmental-land-management-offer#species-recovery-and-management