THE REBALANCE EARTH GUIDE TO

Nature-Based Solutions:

Practical Infrastructure for a Changing World

Rebalance Earth

Foreword

June 2025

As London Climate Action Week 2025 begins, the need to adapt to climate change has never been more urgent. Flooding, drought, and water pollution are already affecting businesses across the UK; disrupting operations, damaging assets, and increasing costs.

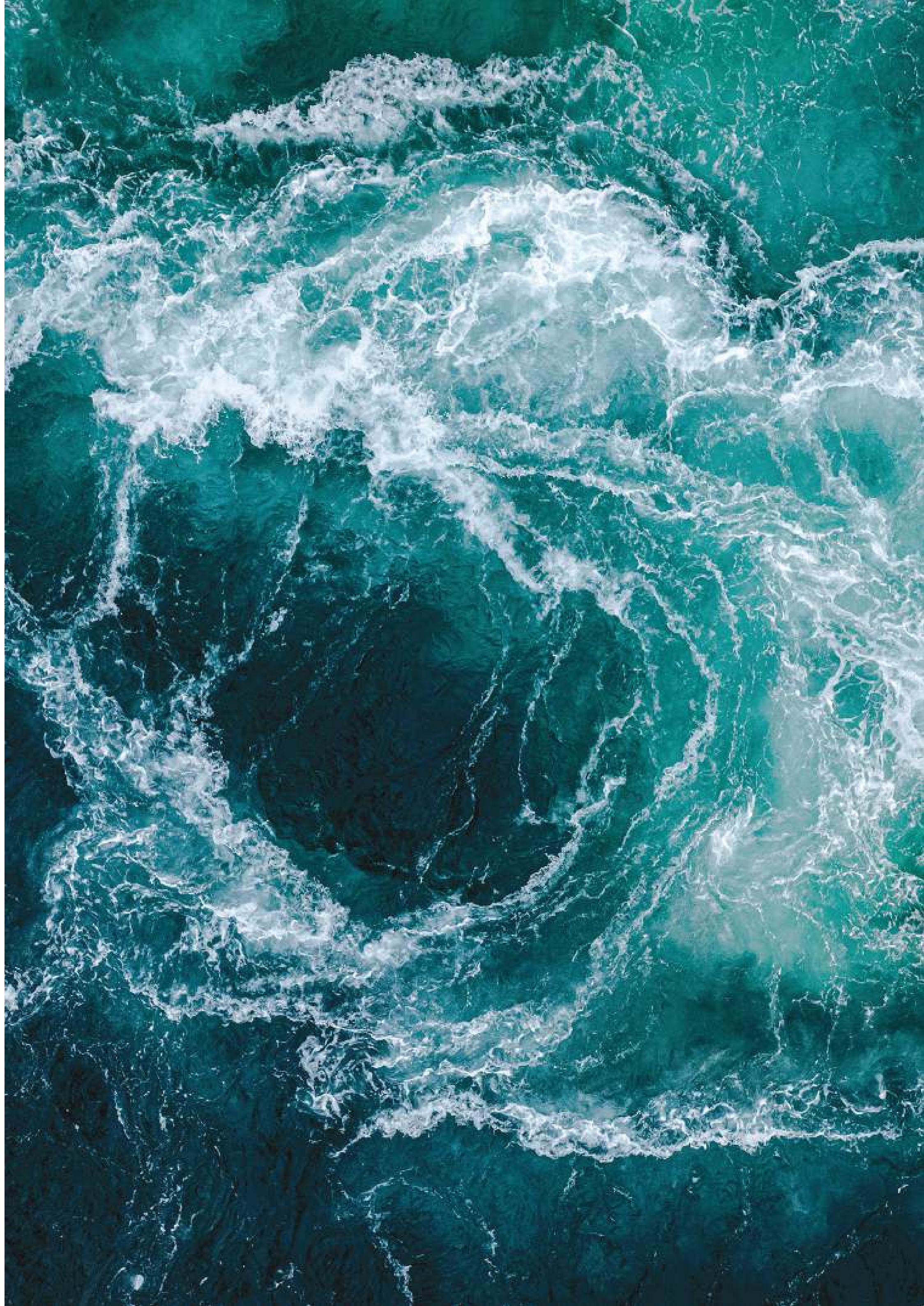
This guide is designed to help businesses and decision-makers understand how Nature-based Solutions can reduce these risks. It provides a practical overview of approaches that use Nature to manage water-related challenges, from flood mitigation to improving water quality and reducing drought risk.

At Rebalance Earth, we see Nature as a form of critical infrastructure: reliable, cost-effective, and essential to long-term resilience. Investing in natural systems is not just an ecological necessity; it's a strategic decision that supports business continuity, protects communities, and delivers lasting value.

We hope this guide supports you in understanding the potential of Nature-based Solutions to mitigate water risks, climate change, and boost biodiversity. These approaches are not theoretical - they are already being used successfully around the world.

Nature is already working for us. It's time we worked with it.

Professor Neil Entwistle
Head of Science, Rebalance Earth



Contents

Introduction

This booklet aims to take you through the range of nature-based solutions that can carry out ecosystem services.

These ecosystem services include:

- Reduced flood risk.
- Reduced drought risk.
- Improved water quality.
- Carbon sequestration.
- Increased biodiversity.
- Improved soil fertility and crop yield.

The nature-based solutions are divided by landscape:

- River & Floodplain Management.
- Woodland Management.
- Landscape Management.
- Coastal & Estuary Management.
- Sustainable Urban Drainage.

Here is how these ecosystem services are provided:

How is flood & drought risk reduced?

- By slowing the flow of water.
- By increasing the storage of water.

How is water quality improved?

- Reducing nutrient concentration (e.g. phosphates and sources of nitrogen (nitrates & ammonium)).
- Excess nutrients cause algal blooms. This blocks out light, killing aquatic plants and boosting the number of decomposer bacteria. These bacteria consume oxygen, creating very low oxygen areas where other organisms cannot survive. This proecess is called **eutrophication.**
- Reducing suspended river sediment.
- Reducing the concentration of carbon dissolved in river water.

How is carbon sequestered?

- Via photosynthesis:
  - Plants absorb carbon dioxide (CO_2) and convert it into glucose through photosynthesis, storing carbon in their tissues.
- Via trapping carbon containing sediments:
  - Plants help trap carbon-rich sediments in the soil. In waterlogged environments, such as wetlands and peatlands, the lack of oxygen slows down decomposition. This prevents carbon from being released back into the atmosphere, keeping it stored in the soil for long periods of time.

River & Floodplain Restoration

River Restoration is the *reinstatement* of dynamic processes and natural features in a river.

What does it involve?

- Re-wiggling rivers
- Reconnecting the river with its floodplain
- Creating pools, riffles and rapids
- Removing man-made structures
- Removal of dams & impoundments
- Opening culverts
- Removing underground pipes and drainage
- Removal of embankments or levees

Benefits:

- **Reduces flood risk by:**
  - *Temporarily storing water, which delays and reduces flood peak.*
  - *Slowing down water,* reducing flow energy towards towns and cities.
- **Reduces drought risk** by *storing more water* in the area.
- **Increases biodiversity** by increasing the number of water habitats (e.g. riffles, pools, runs, and glides).
- **Improves water quality** by encouraging *natural sediment management.*
- **Sequesters carbon** by *trapping carbon* containing *sediment*.

River & Floodplain Restoration in Action

Improved Water Quality:

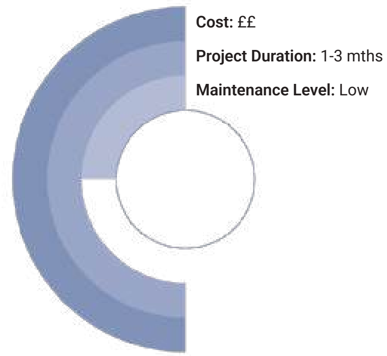
The construction of embankments typically restricts the natural flow of a river. On the River Caldew, Cumbria, embankments fell into disrepair. This allowed the river to re-naturalise and led to annual **local deposition** of **$7{,}000\text{m}^3$ of sediment.** Had the flow not been re-naturalised, this sediment would have been transported downstream to Carlisle resulting in lower water quality and would have required dredging. Allowing the river to re-naturalise helped improve water quality and **lowered dredging costs for Carlisle City Council.**[2]

Flood Risk Reduction & Increased Biodiversity:

The River Glaven, Norfolk was historically modified for water mills and later severely changed through canalisation (over-deepening and installing embankments). This reduced habitats and put 57 properties at risk of flooding. At Humworth Meadows, **a 400 m stretch of river was restored by removing embankments and re-meandering the river.** This created three hectares of floodplain storage. This **significantly lessened the associated flood risk downstream.** The improved channel also **encouraged greater habitat diversity** and led to a notable rise in invertebrate populations.[3]

Flood Risk Reduction:

In the New Forest, Hampshire, rivers were historically straightened to drain land for commercial timber. This reduced habitats and increased downstream flood risk. Flood modelling of a 1-in-100-year flood event identified an estimated 760 residential properties, one emergency centre, eleven electricity substations, and one water treatment plant to be at risk of flooding. To address this, **10km** of straightened and damaged **rivers were 'rewiggled' and reconnected to their floodplains** on the River Lymington, Avon Water, and Hampshire Avon. Wood was also added to the riverbeds to slow the flow. **These changes cut the flood peak by 21% and delayed it by 33%,** sending less water to towns and villages downstream. In addition, the project created 261 hectares of riparian woodland, 18 hectares of bog woodland, 184 hectares of valley mires, and 141 hectares of wetland habitats.[4]



Wetland Restoration

Wetland restoration is the *restoration* of *natural features* which can *hold water.*

Benefits:

- **Reduces flood risk by:**
  - *Temporarily storing water*, which *delays* and *reduces* the *flood peak*.
  - *Slowing down water,* reducing flow energy towards towns and cities.
- **Reduces drought risk** by *storing more water* in the area.
- **Increases biodiversity** by *increasing habitat* for invertebrates, aquatic plants, wetland birds.
- **Improves water quality** by *trapping sediment, nutrients,* and *pollutants.*
- **Sequesters carbon** by *trapping carbon* containing sediment.

What does it involve?

- Restoring features such as: scrapes, fens, grazing marsh & swamp, peat bog, reedbeds, wet woodland, wet grassland, wet heathland, offline ponds, and online ponds.

Over 3500 species of invertebrates, 150 aquatic plants, 22 duck & 39 wader species occur in UK wetlands.[5]

Wetland Restoration in Action

Improved Water Quality:

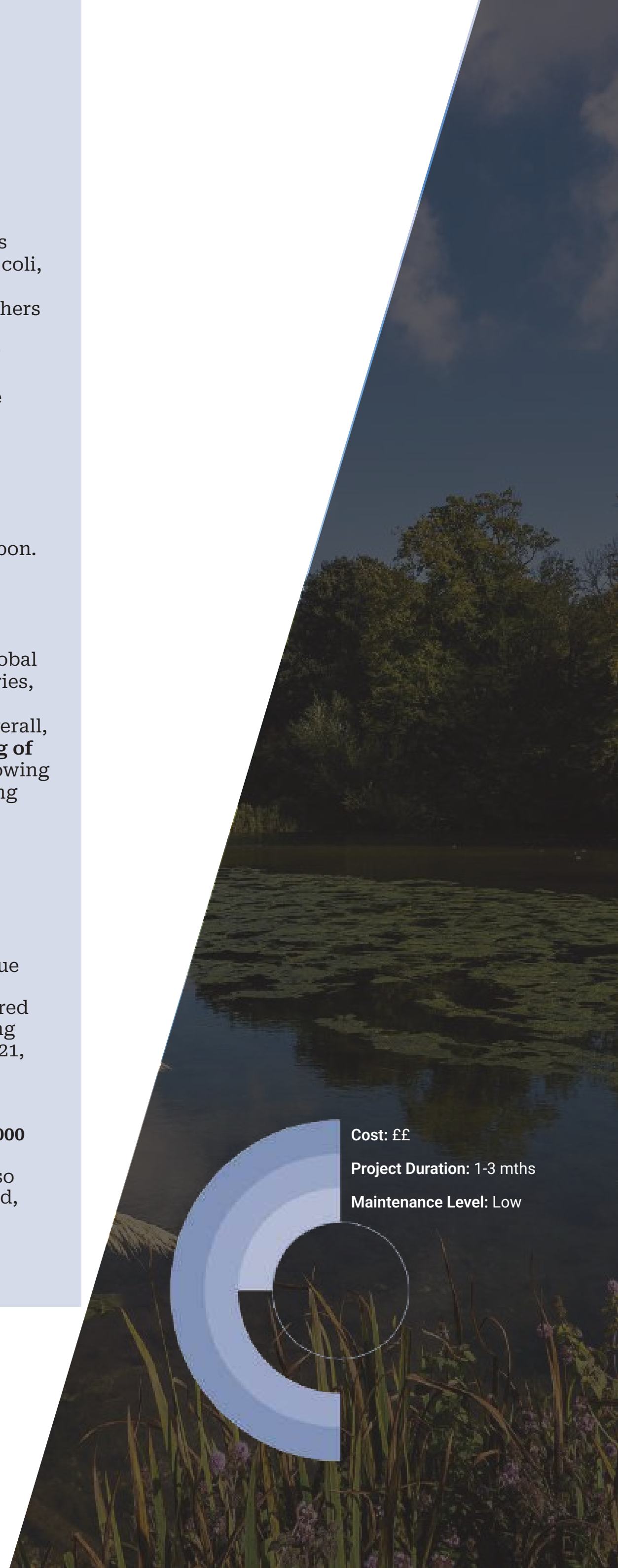
Sewage contains high levels of nitrates and phosphates, and its presence in rivers can be identified by organisms such as E. coli, which indicate faecal contamination. At Holland Brook, Clacton, Essex, researchers analysed water quality and found that **wetlands reduced these faecal indicator organisms by over 97%.** This shows wetlands can significantly reduce sewage contamination, improving water quality and preventing eutrophication.[6]

Carbon Sequestration:

Wetlands trap sediment containing carbon. The wet conditions slow decomposition, reducing the amount of carbon dioxide released into the atmosphere. However, wetlands can also produce methane, a greenhouse gas which contributes to global warming. In a study in the Canadian Prairies, scientists measured both carbon storage and methane release. They found that, overall, **wetlands stored an equivalent of 3,250kg of carbon dioxide per hectare per year,** showing wetlands play a significant role in reducing atmospheric carbon.[7]

Flood Risk Reduction:

The Medway catchment in Kent covers 2,400 km² and often suffers flash floods due to its impermeable clay soils. Historical records showed major flood events occurred about every 10 years, particularly affecting the town of Yalding. Between 2017 and 2021, the Medway Natural Flood Management project created wetlands, storage ponds, and channels to slow runoff and store floodwater. **These measures provided 8,000 m³ of water storage, protecting over 100 properties from flooding.** The project also protected 11 hectares of ancient woodland, created 2 hectares of new wetlands, and established 0.5 hectares of meadow habitat.[8]



Leaky Barriers

Leaky barriers are *wooden barriers* constructed *across river channels* and *floodplains* designed to slow the flow of water.

Benefits:

- **Reduces flood risk** *slowing down* the *flow of water,* reducing flow energy towards towns and cities.
- **Reduces drought risk** by *slowing down* the *flow of water in a river*, allowing for water to be retained in landscapes for longer.

What does it involve?

Constructing wooden barriers across rivers which allow water to pass underneath. Leaky barriers can also involve large woody debris (LWD), these are fallen trees that:

- Create fast and slow flowing areas within the river which provide habitats for different fish species.
- Collect silt which provides an area for aquatic plants to grow.
- Provide perches for kingfishers and hiding spots for fish.

Leaky barriers in Action

Flood Risk Reduction & Drought Risk Reduction:

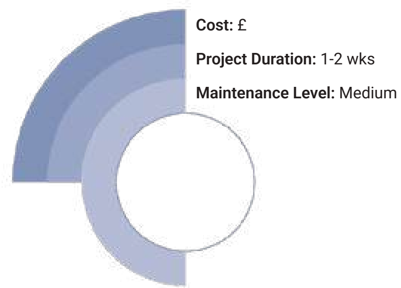
The River Blackbrook, St Helens, floods regularly due to surface water and river overflow. Each year there's a 5% chance of flooding putting homes, businesses and major infrastructure at risk including the A58 – a major link road for lorry traffic. Traditional flood defences were considered too expensive, so instead, four log **dams were installed which stored 2,500m³ of water** (equivalent to an Olympic-sized swimming pool). Additionally, a wetland and a new flood defence bund were created. Flood modelling predicts **these measures will lower flood levels by 900mm during 1-in-100 year flood events.** Furthermore, the log dams naturally filter water, resulting in **phosphate levels dropping by 3.6mg per litre,** reducing eutrophication risk.[9]

Flood Risk Reduction:

Studies on Dean Brook at Smithills Estate, Bolton measured water flow before and after installing 1m high willow log jams. 53 properties on the Smithills Estate were identified as being at high risk of flooding. The **log jams slowed water flow, reducing peak flood levels by 27.3%** and improving dry-period flow by 27.1%. This contributes to reduced flood risk for the properties on the estate. Additionally, the improved water flow during dry periods reduced drought risk.[10]

Flood Risk Reduction & Improved Water Quality:

On the River Tone, Somerset, a study analysed the impact of two sections of leaky dams on peak flow. The project was part of the Hills to Levels project, a partnership between Somerset farmers, aiming to help 'slow the flow' to reduce flood risk, and improve water quality. **Leaky dams were found to reduce peak flow by up to 56%.** This demonstrates how leaky dams can slow the flow of water during storms, reducing the flood risk for towns downstream.[11]



Beaver Introductions & Relocation

Beaver introductions involve the relocation of beavers to areas without beavers.

What does it involve?

- Beavers construct dams out of trees they fell and create channels which reconnect the river with its floodplain. This results in the creation of diverse and complex wetland habitats.
- Their ability to modify the environment to meet their needs means they are often called "ecosystem engineers" or "keystone species".

Benefits:

- Beaver dams **reduce flood risk** by:
  - Increasing water storage.
  - Slowing the flow of water.
- Beaver channels **reduce flood risk** by *increasing floodplain connection*. *Floodplains* can temporarily *store water*.
- **Reduces drought risk** by *increasing water storage.*
- **Improves water quality** by *trapping sediment.*
- Beaver dams dramatically **increase biodiversity** through interlinking benefits:
  - Dams *create pools* for invertebrates, which *bats can feed off*.
  - Beavers *fell trees*, providing *more sunlight* for *forest floor below*. Sunlight allows for *plant growth* on the forest floor. Plant growth provides *food source for other species*.
  - Beaver dams provide habitat for *fish nurseries*.

On the River Otter, in Devon, the beaver dams delayed flood peaks by 55.9%[12]

Beaver Introduction in Action

Flood Risk Reduction, Drought Risk Reduction, & Increased biodiveristy:

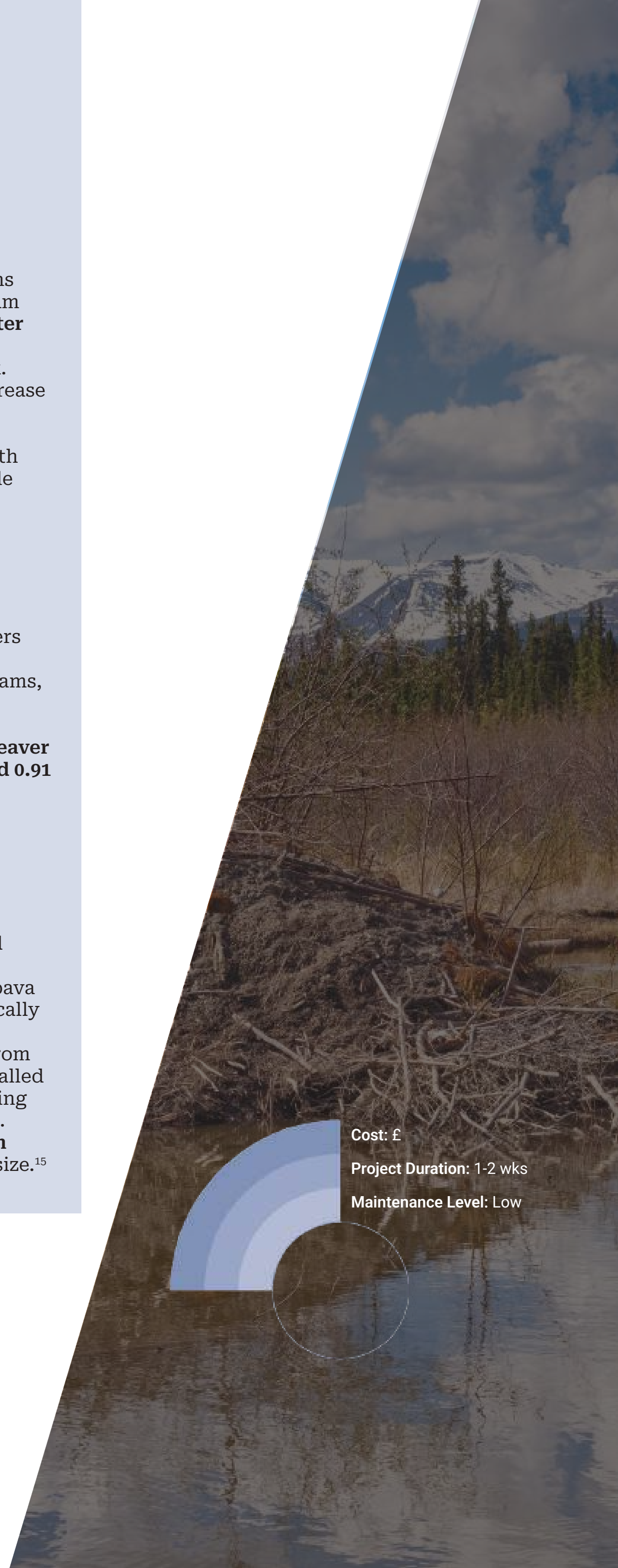
At Bridge Creek, USA, mock beaver dams were built to encourage further beaver dam creation. The **dams increased groundwater by 0.25m** storing more water in the soil and reducing both flood and drought risk. Overall, the dams led to an eight-fold increase in natural beaver dams, significantly improving habitats for wildlife. Juvenile steelhead trout particularly benefited, with habitat availability increasing and juvenile survival rates rising by 52%.[13]

Carbon Sequestration & Improved Water Quality:

At the Mid-Devon Beaver Project, beavers have transformed the landscape from woodland to a fen meadow with ponds, dams, and canals. The ponds store over 70kg of sediment per m², capturing nutrients and improving water quality. **Across 13 beaver created ponds, 15.9 tonnes of carbon and 0.91 tonnes of nitrogen** was stored, helping to regulate climate and improve water quality.[14]

Increased Biodiversity:

In 2018, Czech officials planned to build a £1 million dam and create a wetland on a former army base to protect the Klabava River. This was to protect the river's critically endangered crayfish population from sediment and acidic water spilling over from two nearby ponds. Bureaucratic delays stalled the project; however, beavers began digging channels and building dams on their own. **The work of the beavers saved £1 million** by creating a wetland twice the planned size.[15]



Catchment Woodland

Catchment woodland is the total area of woodland within a river catchment, this includes different types of woodlands such as: plantations, cross-slope, riparian, and floodplain.

Benefits:

- **Reduces flood risk** by:
  - *Increasing* the *water absorbed* by the *soil*, decreasing the flood peak.
  - Slowing down water by interrupting its flow across land, delaying the flood peak.
- **Reduces drought risk** by *increasing water absorption* into the soil.
- **Sequesters carbon** through *photosynthesis*.
- **Increases biodiversity** by *providing habitats* for a range of species.
- **Improves water quality** by *stabilising riverbanks* and *reducing* the volume of *surface water runoff* into the river.

Catchment Woodland in Action

Flood Risk Reduction & Improved Water Quality:

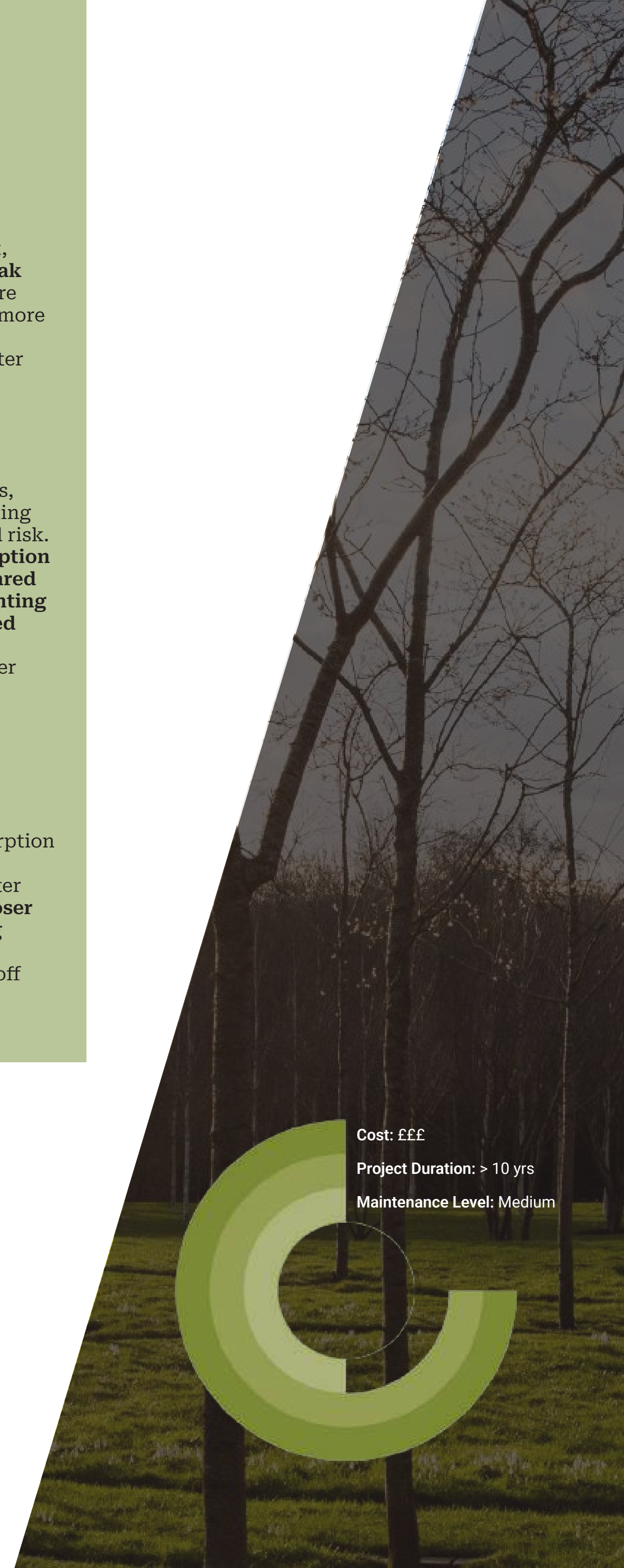
At Haweswater Reservoir, Lake District, **woodland streams had 23–60% lower peak flows** when compared with grazed pasture due to higher soil permeability allowing more water to be absorbed rather than run off into rivers. This lowers the volume of water reaching rivers, reducing flood peak.[16]

Flood Risk Reduction:

In the River Pontbren catchment, Wales, a study analysed the impact of tree planting and prevention of sheep grazing on flood risk. The study found **the rate of water absorption was 67 times higher in woodland compared to sheep grazed pasture. Woodland planting and prevention of sheep grazing reduced surface water runoff by 78%.** This shows its potential to reduce the volume of water reaching rivers, helping to protect towns and cities downstream.[17]

Flood Risk Reduction:

In Warwickshire, a tree planting study investigated how the rates of water absorption were impacted by tree planting on clay soils. The study found that in winter, water **absorption into soils was 76% higher closer to trees.** This demonstrates tree planting allows great water absorption into soil, limiting the volume of surface water runoff into rivers and reducing downstream flood risk.[18]



Riparian Woodland

Riparian woodland is the woodland immediately adjacent to watercourses.

What does it involve?

It usually involves planting trees on one third of the land adjacent to a river. This is to provide a balance between allowing enough light for vegetation growth, whilst stabilising river temperature.

Benefits:

- **Improves aquatic biodiversity** by creating conditions which allow for a greater range of species to survive. Riparian woodland *provides shade* which *stabilises water temperature*, supporting aquatic species. Additionally, they *provide a source of woody material* for the river. This *diversifies the river flow*, providing habitats for a wide range of species.[19]
- **Improves on land biodiversity** by creating structurally complex habitats along riverbanks, providing habitats for organisms such as insects.[20]
- **Sequesters carbon** through photosynthesis.

Riparian Woodland in Action

Improved Water Quality:

A nationwide French study of approximately 2,000 sites including almost 230,00km of rivers found **riparian woodland significantly reduced excess nutrients such as phosphorus and nitrates,** preventing eutrophication. In a 10m wide strip of riparian woodland, more forest cover correlated with a drop in phosphorus and nitrates. Woodland can, therefore, act as a natural filter, preventing eutrophication and improving water quality.[21]

Increased Biodiversity & Improved Water Quality:

A pioneering project in Somerset UK – inspired by techniques first used in Oregon, USA – transformed a simple, static river system into a dynamic, complex habitat with increased wetland diversity by creating a mosaic of floodplain woodland habitat. This supported a wide variety of plants and animals. The project further improved water quality, reducing turbidity and sediment levels downstream. This in turn benefited migratory fish and reduced agricultural pollution impacts. By allowing water to naturally flow across floodplains, the project enhanced the river's resilience to extreme weather events, providing wildlife refuges during droughts and floods.[22]

Flood Risk Reduction:

In the River Avon, Evesham, a computer modelling study showed that **unmanaged riparian forests slowed water flow more than plantations of poplar or pine trees.** This demonstrates the ability of unmanaged riparian to delay the arrival of water into towns and cities, helping to reduce flood risk.[23]

Cost: £££

Project Duration: > 10 yrs

Maintenance Level: Medium

Soil & Land Managment

Soil and land management is the implementation of a wide range of measures which improve soil health. This enhances soil water storage, carbon sequestration, and biodiversity. It is primarily used in agricultural landscapes.

What does it involve?

Soil and land management includes a range of techniques such as, conversion of fencing to hedgerows, increased sward height, reduced stocking density, low or no tillage, cover cropping, crop rotations, intercropping, and soil aeration.

Benefits:

- **Improves water quality** by *reducing erosion* of soil into rivers through *reduced stocking density* and cover cropping.
- **Increases biodiversity** by *converting fencing into hedgerows*. This creates habitats for a range of species.
- **Reduces flood risk** by the implementation of several management techniques: *increased sward height* to slow the flow of surface water, reduced stocking density leading to *reduced soil compaction* to improve water absorption into soil, *limited tillage* to improve soil structure, increase water retention, and *cover cropping* to support soil water absorption along with soil aeration.
- **Reduces drought risk** by increasing the volume of water which can be stored in the soil with techniques such as *increased sward heights, reduced stocking density, cover cropping and soil aeration.*
- **Increases carbon sequestration** by *preserving soil structure* via *limited tillage* which allows for more carbon storage in soil.
- **Improves soil fertility and crop yield.** Legumes can fix carbon; *Intercropping* and *cover cropping* with legumes increases soil fertility reducing the need for fertilisers. Crop rotations also *reduce the prevalence of pests and diseases* by interrupting the disease cycle.

Soil & Land Managment in Action

Flood Risk Reduction & Improved Water Quality:

In Penrith, Cumbria, aerator blades were used to cut into the soil of perennial rye grass pastures. **Aerating the soil reduced the occurrence of surface runoff from 11.4% of rainfall events to below 0.1%.** Lower overland flow results in less soil erosion and improved water quality, as well as reduced flow of water into rivers, easing flood risks downstream.[24]

Increased Farm Net Profit:

In the River Wensum catchment, Norfolk, farmers tested conservation tillage methods (planting seeds directly into the soil or ploughing more shallowly on 143 hectare). After 5 years this resulted in **increased net profits by 13%** due to higher crop yields and lower costs. Additionally, conservation tillage helps preserve soil structure which reduces soil erosion and allows more carbon to be stored in the soil.[25]

Improved Water Quality, Flood Risk Reduction, & Increased Crop Yield:

In Brookings, South Dakota, researchers at the North Central Agricultural Research Laboratory studied how cover cropping affects water infiltration into soil. They found cover crops **boosted water infiltration by 80% helping to reduce flood risk, and increased soybean yields by 14%.**[26]

Cost: ££

Project Duration: > 1 yr

Maintenance Level: High

Run-off Pathway Managment

Run-off pathway management is the introduction of features to interrupt water flow across land. Collectively these features are called run-off attenuation features (RAFs).

Benefits:

- **Reduces flood risk** by:
  - *Slowing* the flow of water, which delays the flood peak.
  - Temporarily *storing water*, reducing the size of flood peak.
- **Reduces drought risk** by *storing more water on land*, so there is more water present during drier periods.
- **Improves water quality** by *preventing the transportation of pollutants* and *sediment*.

What does it involve?

- **Bunds –** raised soil or stone embankments.
- **Wetlands –** areas of land covered by water.
- **Buffer strips –** vegetative barriers along fields or waterways.
- **Cross-slope forestry –** woodland planted across hill slopes.
- **Field drainage reversal –** Removal of systems designed to drain fields such as pipes and ditches.
- **Hedge row planting**
- **Creation of offline storage ponds -** ponds designed to temporarily store water, which are separate from a river.
- **Swales –** shallow holes or channels in the landscape designed to slow down and capture rainwater.
- **Scrapes -** Shallow depressions or manmade hollows in the landscape designed to temporarily store water.
- **Sediment traps –** structures designed to capture and hold soil particles, and pollutants carried by runoff water.

Run-off pathway Managment in Action

Flood Risk Reduction & Increased Biodiversity:

Belford, Northumberland, experienced 10 flooding events between 1997 and 2007. In response 45 natural flood management features including **offline storage ponds** and **soil bunds** were installed. These **trapped 1 tonne of sediment per flood event,** which created abundant habitats for wildlife, including great crested newts – which serve as positive indicators of the broader ecosystem health. Individually, these features **reduced flood peaks by up to 10%,** and collectively provided 12,000m^3 of water storage, greatly reducing flooding. Since their installation, only one property has flooded.[27]

Flood Risk Reduction:

In Holnicote, Somerset, the Environment Agency Flood Map indicated that around 100 properties along with critical infrastructure were at risk of flooding; in 2000 flooding caused the A39 link road to become impassable. In response, various RAFs including offline storage areas, and woodlands were introduced. These **cost £163,000 but protected £30 million of property** (2013 values), reducing flood peaks by 10%.[28]

Flood Risk Reduction:

Velm, a village in Belgium, suffered severe flooding multiple times between 1987 and 2007. To mitigate this, a 12-hectare grassed waterway was installed along a 300 hectare dry valley This significantly reduced runoff and slowed water flow to Velm and Gingelom. As a result, flood severity decreased. The total cost of these measures in Velm was €351,528—the same amount the village had previously received in compensation for flood damage after the May and August 2002 thunderstorms, demonstrating the cost effectiveness of nature-based solutions.[29]

Upland Land Managment

Upland land management is the management of the uplands to retain water and improve water quality.

What does it involve?

- Peatland restoration via destroying systems that drained peat (e.g. gully/grip/pipe blocking).
- Changing grazing practices to allow for greater vegetation heights (increased sward height).

Benefits:

Changing grazing practices:

- **Reduces flood risk** by:
  - *Increasing vegetation* which *slows* down the *flow of water,* increasing time to flood peak.
  - *Enabling more water to be stored in the soil* and decreasing flood peak.
- **Reduces drought risk** enabling *more water* to bestored *within* the soil.
- **Improves water quality** by *stabilising soil,* preventing it *eroding into rivers.*

Peatland restoration:

- **Sequesters carbon**. The wet conditions of *peatland prevent decomposition*. When peatland plants die, the carbon within the plant is locked in the soil rather than returning to the atmosphere from decomposition.
- **Reduces flood risk** by slowing the flow of water.
- **Reduces drought risk** by *storing more water* within the soil.
- **Improves water quality** by filtering water and absorbing excess nutrients.
- **Increases biodiversity** by creating habitat for peatland species.

Upland Land Managment in Action

Improved Water Quality, Carbon Sequestration, & Flood Risk Reduction:

Exmoor's peatlands were drained for farming in the 19th and 20th centuries, reducing their ability to store water and harming water quality. Dry peat also releases carbon dioxide, worsening climate change, whilst runoff carried carbon into the River Exe, making the water more acidic, discoloured and costlier to treat. To restore the peatland, South West Water and partners installed 15,000 peat and wood blocks to block ditches, raising the water table by an average of 2.65cm. The measures also **reduced storm flows by 33%** and **dissolved carbon by 50%,** reducing South West Water treatment costs.[30]

Flood Risk Reduction, Drought Risk Reduction, & Increased Biodiversity:

In the Peak District, a study found that spreading lime, seed, and fertiliser helped rapid peatland revegetation. **Revegetated peatlands delayed storm flows by 30 mins** and **reduced peak discharge by just under 2 litres per second per hectare.**
By slowing runoff, peatland restoration lowers flood risk downstream whilst also helping the landscape retain more water, reducing drought risk and providing habitat for peatland species, increasing biodiversity.[31]

Flood Risk Reduction & Improved Water Quality:

At Kinder Scout, Peak District, pollution, overgrazing, wildfires, and climate change severely damaged the peatlands, leaving 34% of the land bare by 2009. Restoration efforts, including revegetation and installation of 2,000 gully blocks, reduced this to approximately 4% by 2014. This helped slow water flow, **reducing peak storm flow by 37%** and **delaying the flood peak by 267%,** lowering flood risk for downstream towns. The restoration also improved water quality in the Humber Surface Water Safeguard Zone, which previously was deemed 'at risk' due to high levels of dissolved organic carbon.[32]

Cost: ££

Project Duration: 1-2 mths

Maintenance Level: Medium

Saltmarsh & Mudflat Restoration

Saltmarshes are coastal wetlands often flooded by seawater. They are dominated by plants which can survive in salty conditions (e.g. glassworts).
Mudflats are tidal deposits of fine silt and clay often adjacent to saltmarshes. They are regularly submerged and exposed by tides.

What does it involve?

- Removing barriers (e.g. embankments and seawalls) to allow natural tides to return.
- Replanting native vegetation to stabilise soil.
- Allowing inland migration of saltmarshes as sea levels rise. Adding sediment to combat erosion.

Benefits:

- **Reduces flood risk** by:
  - *Saltmarsh vegetation* and *mudflat sediment absorbing wave energy.*
  - Acting as a *buffer* between towns and the sea.
- **Improves water quality** by acting as a *water filter.*
- **Increases biodiversity** by *creating habitats* for a range of species.
- **Sequesters carbon** by:
  - Saltmarsh vegetation absorbing CO_2 via *photosynthesis* and storing it in their biomass.
  - *Tides bringing in carbon* containing *sediment*, which is trapped in soil by plant roots. These soils are *waterlogged* and *oxygen-poor*, so decomposition is slow, preventing it being released as carbon dioxide.

Saltmarshes & Mudflats in Action

Carbon Sequestration & Flood Risk Reduction:

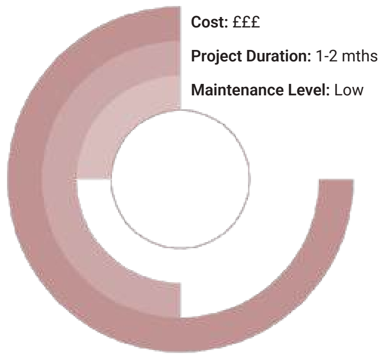
At Steart Marshes in Somerset, saltmarshes were restored to compensate for lost intertidal habitats and improve flood defences. The **restored saltmarsh** now accumulates 75mm of sediment per year, **storing 36.6 tonnes of carbon per hectare annually.** The saltmarsh's waterlogged conditions slow decomposition, preventing carbon release from plant matter as CO_2. The accumulating sediment also helps reduce coastal flood risk by buffering wave energy.[33]

Carbon Sequestration, Improved Water Quality, & Increased Biodiversity:

At Welwick Marsh on the Humber Estuary, Yorkshire, 80 hectares of intertidal habitat has been recreated by moving sea defences landward and shortening them. This approach reduces flood defence costs and offsets habitat loss from rising sea levels. Nearly 460,000 tonnes of sediment accumulated **between 1946 and 1994, storing 14,000 tonnes of organic carbon and 700 tonnes of organic nitrogen.** It also trapped over 200 tonnes of phosphorus and significant amounts of harmful metals, including zinc, lead, arsenic, and copper. This reduction in nitrogen and phosphorus entering the sea, prevents eutrophication. Additionally, the retention of toxic metals helps protect marine organisms from tissue and organ damage.[34]

Flood Risk Reduction:

A study in North Carolina compared the erosion of living shorelines and unprotected coastlines before and after Hurricane Florence in 2018. **Living shorelines experienced far less erosion,** with some areas even **gaining 0.015m per year,** whilst unprotected shorelines eroded at a rate of 0.31m per year. This natural protection reduces the need for costly artificial defences and lowers flood risk for coastal towns like Morehead City.[35]



Sand Dune Managment

Coastal sand dune management is the implementation of measures to support and stabilise sand dunes. This can include introducing vegetation to encourage sand accumulation, and fences to reduce erosion through trampling and trap sand.

Benefits:

- **Reduces flood risk** by acting as *barriers against* strong *wind* and *waves*.
- **Increases biodiversity** by creating a *habitat* for *specialised vegetation* such as marram grass, as well as for *birds* (e.g. sandpipers & terns), *insects,* and *small mammals*.
- **Sequesters carbon** through *dune plant photosynthesis* and through dune plant *root systems trapping organic material* underground.

What does it involve?

- Dune stabilisation through planting vegetation such as marram grass to stabilise dunes, and sand fences to slow down wind speeds, helping sand accumulate.
- Restricting access through fencing and signage to reduce erosion through people walking on them.
- Reprofiling dunes to maintain the protective function against storms.

Sand Dunes in Action

Carbon Sequestration & Improved Water Quality:

Newborough Warren, one of the largest dune systems in the UK, is located on Anglesey in North Wales. Dry dunes store just under 600kg of carbon per hectare per year, whilst **wet dunes store over 700kg of carbon per hectare per year.** Across all dunes, nitrogen accumulation ranges from 16-67 kg per hectare per year, helping to regulate the atmosphere and prevent excess nitrogen from reaching the sea, reducing the risk of eutrophication.[36]

Flood Risk Reduction:

At Nags Head, North Carolina, USA, a study found that **managed dunes grew 1.7x faster than unmanaged dunes** due to fencing and planting of vegetation. These managed dunes provide stronger protection against coastal erosion and flooding by buffering wave energy, helping to safeguard nearby properties.[37]

Improved Water Quality:

Meijendel is the largest dune area in South Holland and an important nature reserve and drinking water source for 1.5 million people.[38, 39] Managed by Dunea, the dunes naturally filter water before supplying it to cities like The Hague, reducing the need for extra treatment. As of 2011, **the dunes produce 50 million m^3 of drinking water per year.**[40] In 1999, the Meijendel nature reserve cost $3.8 million to manage, but delivered an income of $99.2 million[4]. Meijendel is also home to over 250 bird species, making it one of the most bird-rich reserves in the Netherlands.[38]

Reefs

Reefs are shallow submerged structures in the ocean and coastal areas. Such as, oyster and coral reefs.

Benefits:

- **Reduces coastal flood risk** by acting as a *natural breakwater,* reducing wave energy.
- **Increases biodiversity** by creating *habitats* and *breeding grounds* for *fish* and *crustaceans.*
- Oyster reefs **improve water quality** by *filtering water* to *remove excess nutrients, sediments, and pollutants.*

Reefs in Action

Increased Biodiversity:

In Caillou Lake, Louisiana, researchers studied the impact of 80 hectares of restored oyster reefs on fish and invertebrate biomass over three years. These reefs were restored in 2009 using empty oyster shells. **The weight of fish and invertebrates was 212% greater by these reefs compared to nearby mud-bottom areas.** This included commercially valuable species which **increased local fisheries' value by 226%,** or $0.09 per square metre (as of 2015). This demonstrates how restored oyster reefs enhance marine life and can support local fisheries.[41]

Flood Risk Reduction & Increased Biodiversity:

Three 0.6 m-high breakwater oyster reefs were placed on an eroding intertidal mudflat at Kutubdia Island, Bangladesh. These **reefs,** which had naturally recruited oysters, **reduced erosion by 54%,** helped to protect the coastal towns of Dhurung and Kutubdia from further land loss and coastal flooding. Additionally, the **saltmarsh expanded by 1.37m per year behind the reefs** whilst sites without oyster reefs saw saltmarshes retreat by 0.2m per year. Oyster reefs as such were able to reduce flood risk whilst also increasing biodiversity.[42]

Flood Risk Reduction:

The Wadden Sea tidal flats stretch approximately 500km along the coasts of the Netherlands, Germany, and Denmark. These areas used to be protected from coastal erosion by blue mussel reefs. However, these declined due to overfishing in the 1990s. Biodegradable reefs were installed south of the Griend Island to pilot protection against coastal erosion. Results showed the **reefs reduced wave heights by up to 60%,** helping to protect villages such as Harlingen from coastal erosion and flooding.[43]

Submerged Aquatic Vegetation

Submerged aquatic vegetation (SAV) comprises marine plants found in the ocean and coastal areas. There are two main types of SAV: seagrass meadows and kelp forests.

Benefits:

- **Reduces flood risk** by acting as a *natural barrier, slowing waves* as they pass over and reducing wave energy.
- **Improves water quality** by *absorbing nutrients* and *trapping sediment* at the plant's root.
- **Increases biodiversity** by *creating habitats* for organisms such as *fish* and *crustaceans.*
- **Sequesters carbon** through *photosynthesis.*

Submerged Aquatic Vegetation in Action

Carbon Sequestration:

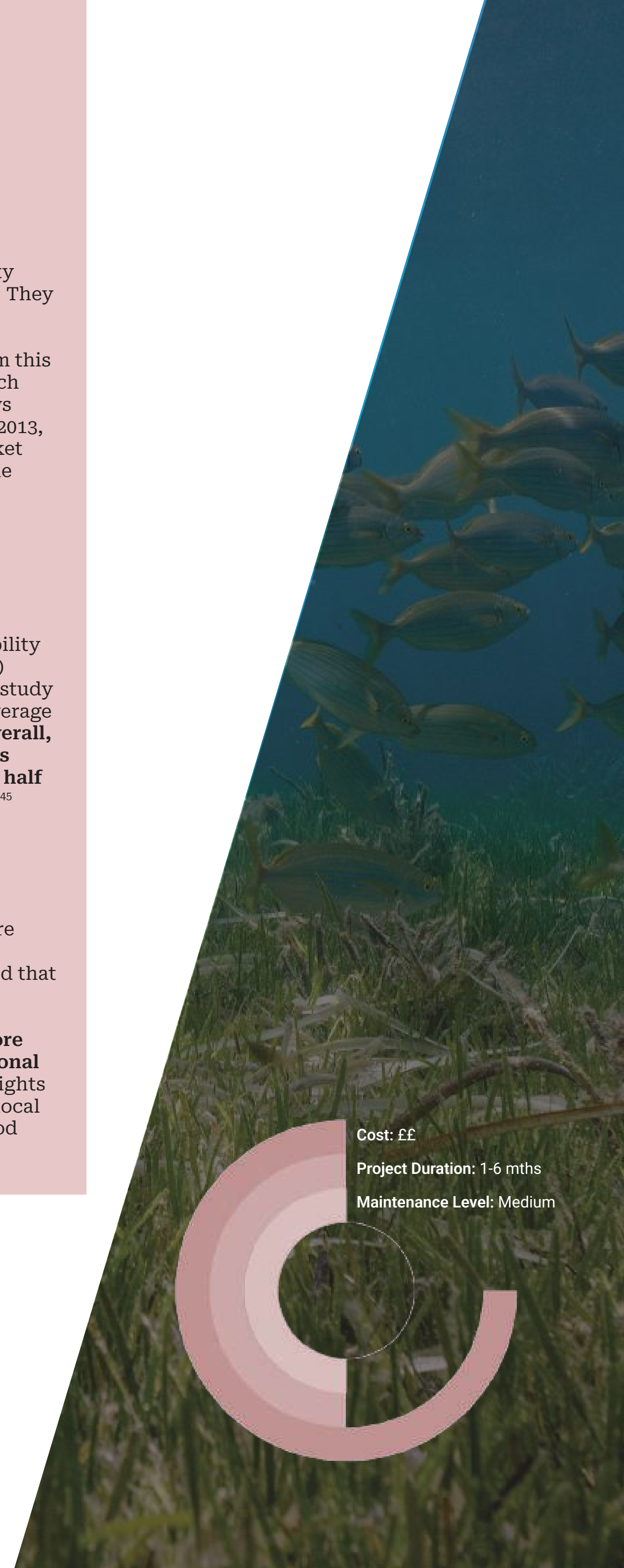
A study of seagrass meadows across 17 locations in Australia examined the ability of three seagrass species to store carbon. They found that **seagrass meadows were able to store between 262 and 4833 grams of carbon per square metre.** Results from this study allowed for estimates to made which showed that Australian seagrass meadows store 155 million tonnes of carbon. As of 2013, this carbon was estimated to have a market value of $3.9-5.4 billion demonstrating the important role seagrass meadows have in sequestering carbon and regulating our climate.[44]

Carbon Sequestration:

A study of existing research into the ability of marine vegetation (including seagrass) to sequester carbon was conducted. The study found that seagrass meadows store an average of 83 grams of carbon per m^2 per year. **Overall, marine vegetation, despite covering less than 2% of the ocean, sequesters nearly half of the carbon stored on the ocean floor.**[45]

Increased Biodiversity:

The environmental impact of a 2 hectare seaweed farm on the Koster Archipelago, Sweden was analysed. The research found that many organisms used the seaweed as a habitat or shelter. When compared with sites without a seaweed farm, **17 more mobile animal species and seven additional seaweed species were found.** This highlights the ability of seaweed farms to enhance local biodiversity by providing habitat and food sources for marine life.[46]



Sustainable Urban Drainage Systems (SuDS)

Sustainable Urban Drainage Systems (SuDS) manage rainwater in towns and cities to reduce flooding, improve water quality, and improve biodiversity. Some use nature-based solutions such like ponds, swales, or green roofs, whilst others rely on engineered solutions such as tanks or trenches. Both aim to slow the water down and allow it to soak away more naturally.

What does it involve?

SuDS can be grouped into three main categories based on their primary function:

- Water infiltration systems.
- Water storage systems.
- Water flow systems.

Benefits:

- **Reduces flood risk** by *capturing* and *slowing down the flow* of *rainwater* during periods of heavy rainfall. This decreases the volume and speed of surface runoff, allowing water to be absorbed into the ground rather than overwhelming drainage systems.
- **Reduces drought risk** by *storing water locally*, providing a source of water during dry periods.
- **Improves water quality** by acting as a *natural water filter*, trapping sediments, nutrients or chemicals.
- **Increases biodiversity** by *creating habitats* for a variety of plant and animal species – bringing nature into the city.

Water Infiltration Systems

Water infiltration systems help rainwater soak into the ground instead of running off into drains. This reduces surface water buildup and runoff, lowering flood risk, and replenishes groundwater supplies, which reduces drought risk.

What does it involve?

Permeable pavements (Engineered)**:**
Surfaces that allow rainwater to soak through. These include porous tarmac, pervious concrete and grass pavers (interlocking paving stones with open areas for grass to grow through).

Infiltration trenches (Engineered)**:**
Gravel filled ditches that collect rainwater and allow it to seep slowly into the ground, which helps to filter the pollutants naturally through the soil.

Soakaways (Engineered)**:**
Underground gravel pits that store rainwater and gradually release it into the ground.

Infiltration basins (Nature-based)**:**
Shallow depressions that hold rainwater and allow it to soak into the soil.

Rain gardens (Nature-based)**:**
Shallow, planted areas that absorb and help filter rainwater, whilst also providing habitats for wildlife.

Water Infiltration Systems in Action

Flood Risk Reduction:

At Red Kite House in Wallingford, Oxfordshire, the car park features both permeable and impermeable pavements, along with a grassed area. Tests quantified the **permeable pavement had a water infiltration rate of 1,925mm per hour.** This was significantly higher than the grassed area, which allowed only 56 mm of water per hour. This reduces surface water runoff and pooling during heavy rainfall, lowering flood risk.[48]

Flood Risk Reduction & Improved Water Quality:

Alma Road in Enfield often flooded because rainwater couldn't soak into the ground and the drains couldn't handle heavy rain. This also pollutes the River Lea, as water runoff from the road picks up dirt and chemicals before flowing into local streams. To mitigate this, **rain gardens** covering 133m^3 were built **holding 37m^3 of water.** They allowed water to drain into the ground rather than collecting in the road. These gardens were designed to handle heavy rain that occurs once every five years.[47]

Improved Water Quality & Flood Risk Reduction:

In Kungsbacka, Sweden, an infiltration trench was installed beneath a supermarket car park to reduce flooding and improve water quality. **The infiltration trench removed 80% of suspended solids, 50% of inorganic nitrogen (such as nitrates and ammonium), and 50% of heavy metals,** preventing pollutants from entering the water supply. With a capacity of 243m^3, the trench also helped prevent the carpark flooding, reducing disruptions and potential revenue losses for the supermarket.[49]

Water Storage Systems

Water storage systems collect and hold rainwater to reduce flooding, provide water during dry periods, and help manage runoff. They store excess water in different ways, either above or below ground, before releasing it slowly or reusing it.

What does it involve?

Rainwater harvesting (Engineered)**:**
Tanks collect rainwater from roofs for reuse in watering plants, flushing toilets, and other non-drinking purposes, reducing reliance on mains water.

Detention basins (Nature-based)**:**
Shallow areas that temporarily hold excess rainwater before releasing it into a drainage system (rather than the ground in the case of infiltration basins).

Constructed wetlands (Nature-based)**:**
Man-made wetland areas that collect, filter, and store rainwater, improving water quality. They also boost biodiversity by creating habitats for plants, insects, and waterfowl.

Retention pond (Nature-based)**:**
Man-made ponds which permanently store water, controlling runoff while filtering pollutants and providing habitats for wildlife.

Underground Storage Tank (Engineered)**:**
Large tanks buried beneath the ground that store excess rainwater below ground, reducing runoff in urban areas and slowly releasing water to prevent flooding.

Green roofs (Nature-based)**:**
Rooftops covered with vegetation that absorb, store, and filter rainwater, reducing runoff. They also insulate buildings and boost biodiversity by creating habitats for wildlife.

Water Storage Systems in Action

Flood Risk Reduction:

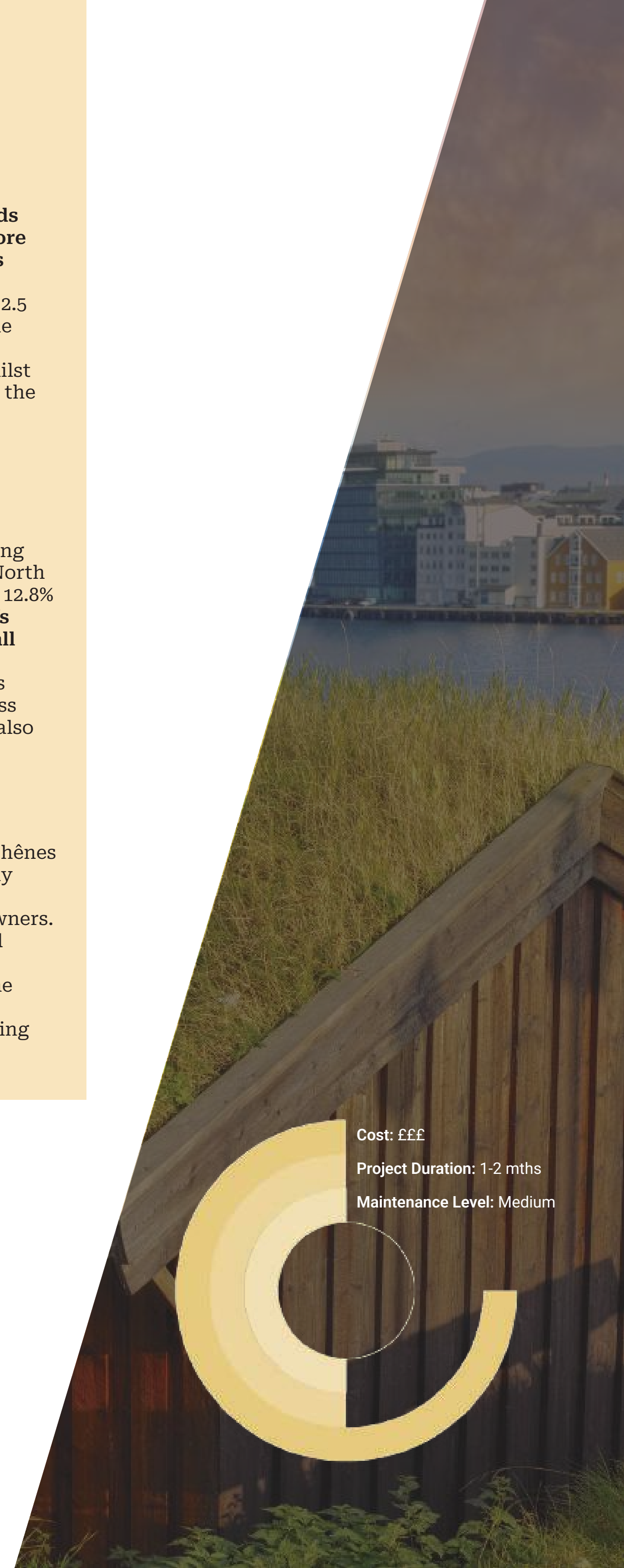
In Salford, **5 hectares** of **urban wetlands** were created. These were able to **hold more than 250 Olympic sized swimming pools worth of water, protecting almost 2,000 homes and businesses from flooding.** A 2.5 km footpath was also installed around the outside of Kersal wetlands, which can be used by both runners and cyclists, whilst also providing another route to and from the centre of Manchester.[50]

Flood Risk Reduction & Increased Biodiversity:

Green roofs can absorb water, preventing water runoff. In the Bahçeköy region of North Istanbul, green roofs prevented between 12.8% and 100% of rainwater runoff. **Green roofs produced approximately 30% less rainfall runoff compared to conventional roofs.** By absorbing more rainwater, green roofs help manage flood risks and reduce excess water entering drainage systems, whilst also providing a habitat for species.[51]

Flood Risk Reduction:

In 1995, a retention pond was built in Chênes Bourgerie, Geneva, to store approximately 450m³ of water whilst also serving as a recreational space for private landowners. Before the pond was built, the watershed could only store 279m³, therefore, the retention pond significantly increased the total water storage capacity. This helped reduce local flood risk whilst also providing a space for people to enjoy.[52]



Water Flow Systems

Water flow systems help control the movement of rainwater, directing it safely to prevent flooding, erosion, and pollution. They guide, slow down, or filter water before it reaches drains, rivers, or the ground.

What does it involve?

Swales (Nature-based)**:**
Shallow, vegetated channels that slow and direct rainwater, allowing some to soak into the ground while filtering pollutants and supporting wildlife.

Bioswales (Nature-based)**:**
Enhanced swales with deeper rooted vegetation and engineered soil (mix of sand, compost and topsoil) to improve water filtration, reduce runoff, and increase biodiversity.

Rills (Engineered)**:**
Small, shallow channels that guide rainwater across surfaces like parks or gardens, helping to control flow and prevent erosion.

Permeable Channels (Engineered)**:**
Paved drainage channels with gaps for water to infiltrate into the soil.

Water Flow Systems in Action

Flood Risk Reduction & Improved Water:

A study conducted on the University of California, Davis campus demonstrated that **bioswales effectively reduced surface runoff by 99.4%,** helping to prevent excessive water from overwhelming drainage systems. Additionally, **bioswales significantly improved water quality by reducing nutrient and dissolved carbon levels by over 99%.** This reduction in nutrients minimises the risk of eutrophication and improves water clarity by lowering dissolved carbon concentrations, which can cause discoloration.[53]

Flood Risk Reduction:

In St. Ann, Missouri, rainwater often collected on roads, causing potholes that needed frequent repairs. To fix this, the city built four swales to catch and drain water from over six acres of land. These **swales were designed to hold the flows from heavy rainfalls of up to 289mm,** preventing it from pooling on the road and creating potholes.[54]

Flood Risk Reduction & Improved Water Quality:

A study assessed how well bioswales manage flood risk and improve water quality. Results showed that bioswales reduced surface runoff by nearly 89%. They also removed a high percentage of pollutants from the water: 95% of nutrients such as nitrates and phosphates, 87% of metals, and over 95% of both dissolved carbon and suspended solids. By filtering out these substances, bioswales help prevent eutrophication, reduce contamination risks, and improve water clarity and quality.[55]

Glossary

Key Definitions:

- **Nature-based solution –** Working with natural processes to manage environmental challenges to improve resilience.
- **Natural flood management –** Nature-based solutions designed to prevent flooding.
- **Ecosystem service –** The benefits to people that are provided by ecosystems.

Definitions:

- **Base flow –** The normal, steady flow of a river that comes from groundwater, not rainfall.
- **Bioswales** – Enhanced swales with deeper rooted vegetation and engineered soil to improve water filtration, reduce run-off and increase biodiversity.
- **Breakwater reefs –** underwater structures made of rock, coral, or concrete which help reduce wave energy and protect the shoreline from erosion.
- **Bunds –** Raised embankments made of soil or stone to control water flow and soil erosion.
- **Buffer strips –** Areas of vegetation planted along fields or waterways which act as natural barriers.
- **Catchment woodland –** The total area of woodland within a river catchment.
- **Constructed wetlands –** Man-made wetland areas that collect, filter and store rainwater.
- **Conservational tillage –** A method for planting crops which reduces the disturbance of soil, preventing soil erosion and improving soil health.
- **Cover cropping –** Growing crops on fields during the off season rather than leaving them bare.
- **Cross-slope forestry –** Woodland planted across hill slopes.
- **Crop rotations –** Rotating the crops grown on each field every year.
- **Crop yield –** The amount of a specific crop produced per area of land.
- **Culverts –** Underground water pipes containing rivers.
- **Dams –** channel spanning walls built across a river to block or control water levels.
- **Detention basins –** Shallow areas that temporarily hold excess rainwater before releasing it into a drainage system.
- **Direct drill –** A way of planting seeds straight into the soil without ploughing
- **Drains –** underground piped network draining floodplains or fells usually in a network across the landscape.
- **Dredging –** The removal of material (e.g. sediment, vegetation, or rubbish) from the bed of a river, harbour, or sea bed.
- **Embankment –** A raised structure built to hold back water, support roads, or prevent erosion.
- **Eutrophication –** Eutrophication is when too many nutrients, such as nitrates and phosphates, enter rivers, lakes, or coastal waters, causing excessive plant and algae growth. This blocks out light, killing aquatic plants and boosting the number of decomposer bacteria. These bacteria consume oxygen, creating very low oxygen areas where other organisms cannot survive.
- **Faecal Indicator Organism (FIO) –** a type of bacteria, e.g. E.coli that signals the presence of sewage contamination in water.
- **Fallow field –** A field left unplanted for a period to allow the soil to recover its nutrients, moisture, and fertility.
- **Fens –** Wet marshy areas where the ground is soaked with water.
- **Field drainage reversal –** The undoing of systems designed to drain fields such as ditches and pipes.
- **Flood flows –** The large, fast moving volumes of water in a river caused by heavy rainfall or flooding.
- **Flood peak –** The highest water level or flow during a flood event.
- **Floodplain woodland –** Woodland within a floodplain.
- **Full tidal exchange –** The complete movement of tidal water into and out of a coastal area.
- **Glides –** Smooth, moderately fast flowing sections of the river with an unbroken surface.
- **Green roofs –** Rooftops covered with vegetation that absorb, store, and filter rainwater, reducing run off.
- **Grip –** A small shallow ditch or trench, often made for drainage purposes in fields or roadside.
- **Gully –** A deep and wide channel formed by water erosion, this is usually on sloping land.
- **Headwater catchment –** area around the source of the river, where rainwater, melted snow or springs collect.
- **Hydraulic conductivity –** The ability of soil or rock to let water pass through it.
- **Impoundments –** water that gets trapped behind a dam.
- **Infiltration basins –** Shallow depressions that hold rainwater and allow it to soak into the soil.
- **Infiltration trenches –** Gravel filled ditches that collect rainwater and allow it to seep slowly into the ground.
- **Intercropping –** Growing two or more crops in the same field at the same time.
- **Irrigation –** The process of adding water to land or crops when there isn't enough rain.
- **Lag time –** The time between heavy rainfall and the peak flow of water in a river.
- **Large wooden debris (LWD) –** Trees that have fallen or been placed in river channels.
- **Lateral Erosion –** Sideways wearing away.
- **Leaky barriers –** Wooden barriers constructed across river channels.
- **Levee –** A type of embankment built especially for flood control.
- **Light detection and ranging (LiDAR) –** A technology that uses lasers to measure the height and shape of the land.

- **Living shorelines –** Natural coastal barriers made of plants, sand, and rocks which help to prevent erosion, protect habitats and support marine life.
- **Managed woodland –** Woodland that is actively maintained to control tree growth, improve biodiversity, and slow down water flow to increase time to flood peak.
- **Mudflats –** Expanses of fine silt and clay deposited by tides.
- **Mycorrhizal biodiversity –** The diversity of fungi within the soil.
- **Native plants –** Plants which naturally occur in a specific region rather than being introduced by humans.
- **Nitrates and Ammonium ions –** a form of nitrogen found in water that can be absorbed by plants.
- **Offline ponds –** Ponds not connected directly to a river.
- **Online ponds –** Ponds directly connected to a river.
- **Organic matter –** Decomposed plant and animal material.
- **Overland flow –** The flow of water across land before it reaches a stream.
- **Peak discharge –** The highest volume of water that passes through a river at a specific time, usually after a rain.
- **Peak discharge –** The highest volume of water that passes through a river at a specific time, usually after a rainfall event.
- **Peak flow –** The highest rate of water flow in a river at a specific time, usually after a rainfall event.
- **Peak storm discharge –** The highest volume of water that passes through a river at a specific time, usually after a storm.
- **Peak storm tide wave height –** The tallest wave during high tide in a storm.
- **Perforation –** Making holes (within the soil).
- **Permeable channels –** Paved drainage channels with gaps for water to infiltrate into the soil.
- **Permeable pavements –** Surfaces that allow rainwater to soak through.
- **Pipe –** A narrow underground tunnel formed which are either man made or formed via water erosion.
- **Ploughing –** A deeper type of tillage using a plough.
- **Pools –** Deeper spots in the river where the water moves more slowly.
- **Rain gardens –** Shallow, planted areas that absorb and help filter rainwater, whilst also providing habitats for wildlife.
- **Rainwater harvesting tanks –** Tanks that collect rainwater from roofs for reuse.
- **Rapids –** Fast flowing high energy areas of the river with large waves and splashing.
- **Rate of erosion –** The speed at which land wears away, often due to wind or water over time.
- **Re-wiggling rivers –**The restoration rivers to their natural shape by removing human influences.
- **Reed-beds –** Wet area covered with tall, grassy plants called reeds.
- **Reefs –** reefs are shallow, submerged structures in the ocean and coastal areas (e.g. oyster and coral reefs).
- **Reduced tide area –** A coastal or estuarine zone where natural tidal flow is restricted or limited. This is often due to human-made structures such as seawalls.
- **Retention ponds –** Man-made ponds which permanently store water, controlling runoff while filtering pollutants and providing habitats for wildlife.
- **Riparian woodland –** Woodland located in the land immediately next to a water course.
- **River restoration –** The reinstatement of dynamic processes and natural features in a river.
- **River source –** The point where the river begins.
- **Run-off attenuation features (RAFs) –** Features designed to interrupt the flow of water across land.
- **Salt-marshes –** Coastal wetlands which are periodically flooded by seawater.

- **Sand dunes –** Landforms made up of sand which has been deposited by wind and trapped by vegetation or obstacles such as fences.
- **Scrapes –** Shallow depressions in the land.
- **Sediment traps –** Structures designed to capture and hold soil particles and pollutants carried by runoff water.
- **Soakaways –** Underground gravel pits that store rainwater and gradually release it into the ground.
- **Soil & Land Management –** involves techniques which improve soil health, allowing it to store more water, sequester more carbon, and harbour greater invertebrate and mycorrhizal biodiversity.
- **Soil aeration –** Process of adding air to the soil by loosening it up or making small holes.
- **Soil moisture content –** Amount of water present within soil.
- **Soil Organic Carbon –** The carbon stored in soil from decomposed plants and animals.
- **Soluble reactive phosphates –** A type of phosphorus dissolved in water that plants and algae can absorb. These are often linked to pollution.
- **Stocking density –** The number of livestock per area.
- **Storage bunds –** low walls or ridges made of earth built to hold water in a specific area.
- **Storm discharge –** The total volume of water passing that passes through a river during a storm.
- **Storm flow –** The extra volume that enters a river due to rainfall during a storm.
- **Storm flow delay –** The time it takes for rainwater to reach the river after a storm.
- **Submerged aquatic vegetation –** Marine plants found in the ocean and coastal areas.
- **SuDS –** Systems in urban areas that mimic natural drainage to reduce flood risk, improve water quality, and improve biodiversity.
- **Surface runoff –** Water that flows over land instead of soaking into the soil.
- **Sward height –** Vegetation height
- **Swales –** Shallow holes or channels in the landscape designed to slow down and capture rainwater.
- **Tillage –** The process of digging or breaking up soil to prepare it for planting crops.
- **Total discharge –** The total volume of water that passes through a river for a specific event.
- **Underground storage tanks –** Large tanks buried beneath the ground that store excess rainwater below ground.
- **Unmanaged woodland –** Woodland left to grow naturally without human intervention.
- **Wader species –** Birds which live in shallow water habitats.
- **Water flow systems –** Systems that help control the movement of rainwater, directing it safely to prevent flooding, erosion, and pollution.
- **Water habitat life-cycle –** The natural progression of life within aquatic organisms, from the formation of the habitat to its first colonisation to its eventual decline or renewal.
- **Water infiltration –** The process of water soaking into the ground.
- **Water infiltration systems –** Systems which help rainwater soak into the ground rather than running off into drains.
- **Water residence time –** The average time water stays in a river, lake, or reservoir before moving elsewhere.
- **Water shed –** An area of land that collects and channels rainwater into rivers, lakes, or other water bodies.
- **Water storage systems –** Systems that collect and hold rainwater to reduce flooding, provide water during dry periods, and help manage runoff.
- **Wave attenuation rates –** The rate at which waves lose energy.
- **Wet grassland –** Grassland growing in a waterlogged area.
- **Wet woodland –** A forest or group of trees in a waterlogged area.
- **Wetlands –** Areas of land which hold water.

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