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National Trust

Climate Change Adaptation – Water

Rivers

Climate change vulnerability: High

Rivers – introduction

Rivers connect places in a unique and special way. From source to sea, flowing through our historic and beautiful places, rivers are utilised and enjoyed, and support the life of the land. By working with local communities, organisations, landowners and tenants, we are creating better, more joined-up habitats for rivers, which are rich in wildlife and resilient to climate change.

Although rivers are usually associated with climate-related impacts on housing, people and land, for example, they too can be impacted by climate hazards. Nevertheless, rivers can provide significant synergies in adaptation measures for other assets and activity affected by flooding and storms.

Much of the impact on rivers results from direct human interventions on river channels and water quality (run-off from agriculture and other pollution). River courses have been changed and constrained – disconnected from their floodplains – which means that climate change impacts are exacerbated. We are not holding or storing water in the landscape any more so it is more prone to flooding from run-off.

The National Trust's improvements for rivers hold many benefits for climate adaptation: slowing the flow, increasing percolation and increasing attenuation through 'roughing' of the landscape. We are also working with land managers to reduce inputs and keep land covered in crop during stormy weather. All of these actions help water quality and quantity in flood and drought.

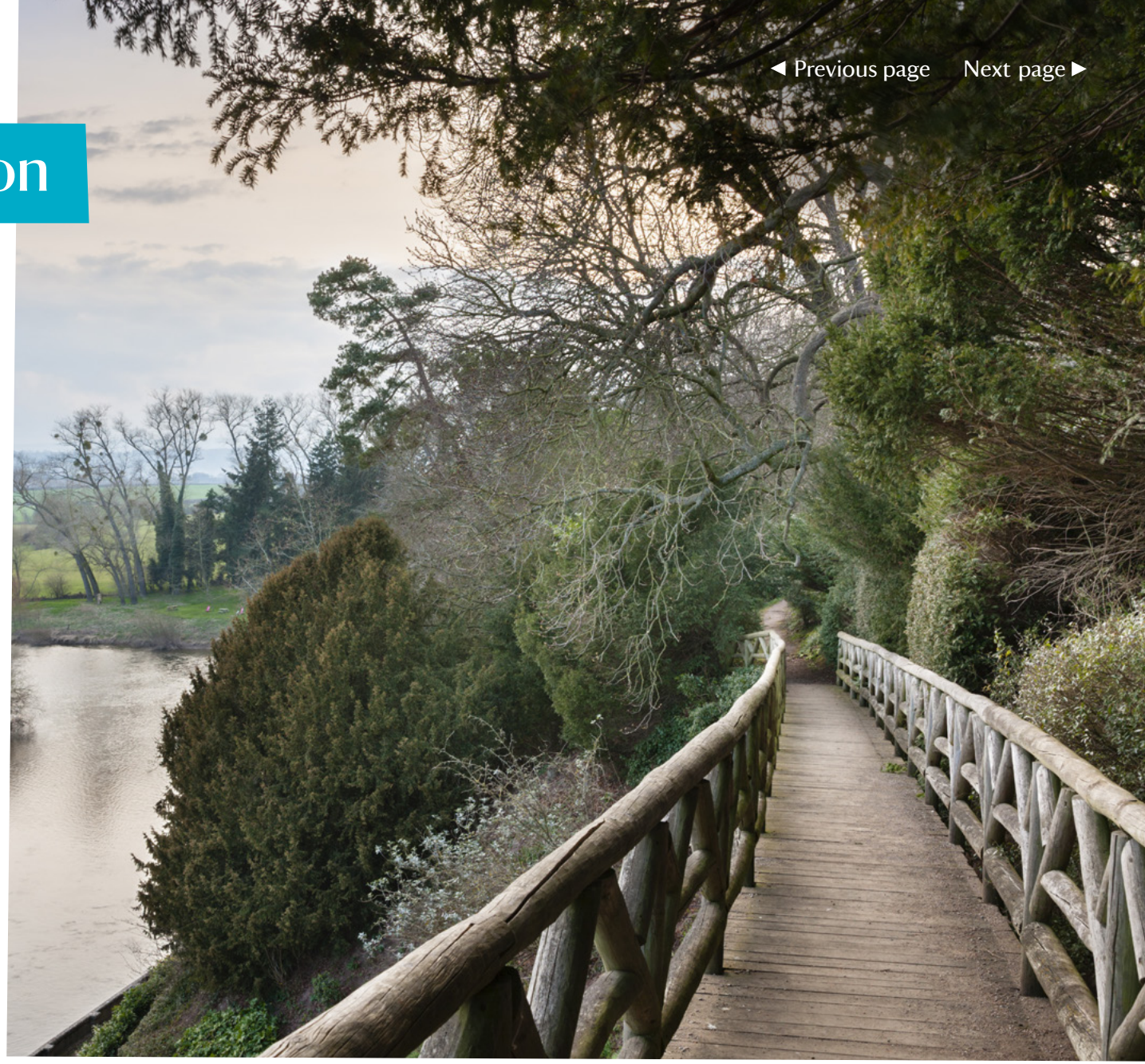


Image credits:

The River Wye as it flows through The Weir Garden, Herefordshire – much of the river is a SSSI and is under pressure from development, run off and nutrients (© National Trust Images/Andrew Butler)

Rivers – why do they matter?

Rivers are the lifeline of our landscapes and as drought reduces our watercourses to a trickle in the summer, or dries them up completely, people and habitats suffer. Flooding and storms can bring pollution from sewage, and pests and disease can leave stretches of freshwater devoid of life, affecting the ecosystems that the water supports.

The principal impact of rivers is on biodiversity. Freshwater habitats are one of the most biodiverse habitats in the world and one of those most at risk. Adaptation and river conservation work matter because they will help address the risk to flora and fauna in freshwater.

Flooding and drought adaptation work will help to retain water in the landscape, which will in turn address impacts on other aspects of place, such as grasslands and parks.

Adaptation can also improve the quality of our drinking water, almost all of which comes from rivers and may return there at some point. The better the quality of this water, the less artificial treatment it needs before it reaches the tap.

As well as biodiversity, adaptation is about creating healthy landscapes. We can achieve this through natural processes and by restoring functioning ecosystems. By making groundwork interventions and influencing land management behaviour, we can address the harm that has been done to watercourses over the centuries. If we can do this whilst conserving a rich cultural heritage of water management and use, we can tell important and informative stories about water sourcing and efficiency which can inform our adaptation measures.

All our work using nature-based solutions will have an impact on adapting to climate change. Interventions that enable the river to work with its natural processes can help build climate change resilience. This raises the fundamental question and starting point for decision-making: can we allow rivers to behave as they want?

Image credits:

Volunteers work to remove habitat under licence to rescue white clawed crayfish ahead of watercourse conservation work at Croft Castle, Herefordshire (© National Trust Images/Imogen Wood)

Rivers – hazards, impacts and options

Hazard	Impacts	Options
Flooding	Contamination (biological, sediment run-off), overflowing, channel change (modified rivers more heavily affected)	Design alterations to inlets (spillway upgrades, freeboard increase), design alterations to surrounding land to avoid impacts, natural flood management, floodplain reconnection
Drought	Evaporation, low flows, less groundwater recharge, increased retention times (where rivers are impounded), interaction with water quality, temporary use bans rolled out, hierarchy of use in periods of drought	Land management changes to encourage groundwater storage (block land drains, reduce compaction, improve soil health) and reduce nutrient loading, increased water storage on site to allow topping up, reduce compounding pressures such as access and use, increased groundwater retention capability of surrounding catchment land use, connect rivers to floodplains (reducing barriers between rivers and surrounding land by removing embankments such as levees and berms), look at alternatives to abstraction where this is practised
Landslides/ coastal erosion	Structural damage, subsidence, saline intrusion	Preparation of emergency plans for dealing with watercourse failure (particularly where connected to large water bodies, and where these are considered to be medium–high risk, and weak points could breach and impact people/pose a risk to life)
Heat	Algae (may result in closure due to health and safety), ecological impacts, increased recreational use/loading (may result in access closures), loss of aquatic life (specifically fish kills)	Reduce nutrient loading to reduce chances of algae (land management changes and water quality improvements), increasing or retaining shade around watercourses (particularly along south margin)
Storm rainfall and damage	Increased sediment loading, increased nutrient loading, overflowing	Land management changes targeted at whole catchment, land use change in vulnerable areas, increased attenuation capacity (tree planting, natural flood management), moving access points, arable reversion alongside riparian zone, broaden field margins along watercourses

Rivers – options and thresholds

Our rivers have been adapted, diverted, culverted, shaped, smoothed, polluted and altered beyond recognition of natural river systems. While this human intervention over time is significant in its own right, the inability of a river to function has unintended consequences for water quality, habitats, geomorphology, nature and in the end for people as well. Large-scale change is likely to require multiple stakeholder buy-in and considerable partnership working to create a natural river system which is more resilient to climate hazards.

Specific options for improvements and changes include:

Floodplain reconnection – through understanding and unpicking interventions – such as levees and embankments, and culverts and canalisation of rivers – rivers can be reunited with their floodplains which will help them to deposit silts, reduce flooding further downstream and restore natural processes to habitats.

Land use change – the entry of nutrients and silt into watercourses is a significant problem, especially when compounded by heat and drought. With low flows, rivers can be more susceptible to algal blooms and invasive vegetation if the water does not receive enough oxygen and is not well shaded. Introducing shade and buffers to watercourses that reduce sediment loading will help reduce the frequency of maintenance interventions. Looking at potential nutrient loading from catchment-sensitive farming options might present opportunities to manage land differently to reduce nitrate loading.

Waste water treatment – while dealt with by compliance regulations to a certain extent, many rural estates and properties have private waste water treatment or septic tanks. The outfalls of such systems often increase the biological oxygen demand, ammoniacal nitrates and phosphates entering a watercourse. This is reduced by the distance between the outfall and the watercourse, but can be further reduced by the level of treatment provided to the waste water prior to its dispersal/outfall. More recently, phosphate reducing interventions are being encouraged which can be retro-fitted to existing systems to lessen nutrient loading of watercourses. However, these systems come with their own cost and sustainability issues and should be designed carefully through a waste water systems consultant.

Nature-based solutions – increasing the ability of land in the upper catchment and either side of a watercourse to attenuate flow during flood events will help to protect the river itself from scarring and pollution. It will also alleviate damage from the river flooding in concentrated locations. Interventions include beaver dam analogues, introduction of beavers, tree planting and land use change (see above).

The Flood and Water Management Act 2010 governs various considerations around water quality and development (including drainage) that impacts watercourses. This means that associated consents are required for certain adaptive works.

Thresholds & tipping points

At what point might you diverge from your current maintenance/management strategy? What are the events/impacts that may trigger this change of approach (action/philosophy)?

- Channel change for the National Trust is delivered through targeting where river changes can have the most impact for nature and people (reducing risk and enhancing biodiversity)
- Flood events and defence breaches
- There is no reason to be reactive on watercourse adaptation, but prioritising resources to deliver the best value and impact might be a consideration
- The naturalisation of rivers is not always possible, so working with landowners, local authorities and other interested parties is key to understanding where adaptation is possible and where impact will be greatest (including indirect benefits such as flooding reduction to settlements)

Consents and permissions

One option is to **do nothing** and another will be to **maintain** the river as it is. Rivers are one of the few asset types where typical maintenance can be harmful to adaptation. Leaving fallen trees in the river can be better for slowing the flow and reducing sediment than clearing debris out of the river. It is about identifying the right maintenance regime for the location to support safety and a functioning ecosystem. Any physical interventions may require **planning permission.**

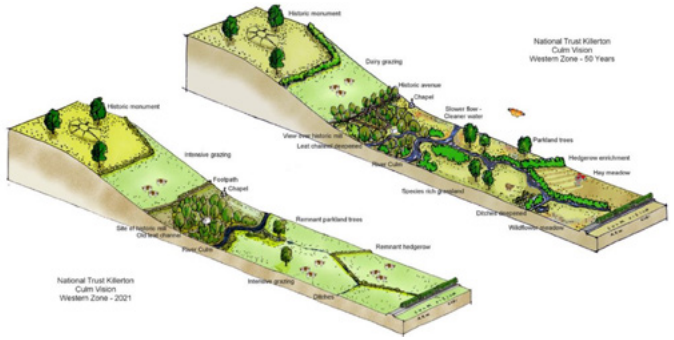
Rivers — worked pathway example

In other sections of this guidance, we have developed pathway approaches to adaptation. These show a range of options and connective paths which diverge, based upon thresholds, and help plan in the face of uncertainty. Although rivers have multiple options for change, the permissions and scale of change to naturalise, reconnect and carry out groundworks is such that interventions are likely to be done in one phase. This means that adaptation takes place proactively and is unlikely to be triggered. The pathway below is illustrative; it shows how and when your adaptive response may change and evolve.

Working with a multi-disciplinary group to think about options and thresholds for a typical site is key. This cannot be done in isolation as there are significant implications for impacts on more than one aspect; for example, ecology, archaeology, aesthetics and agriculture. It is more effective to bring together the right people to work on a mutually acceptable solution for a period of time between thresholds for change.

Rivers are focuses of human activity throughout history, which often makes them archaeological hotspots. Therefore, archaeology should always inform the approach and be considered when designing and mitigating for groundwork interventions. Rivers also form key components of landscape and views; aesthetics and significance within designed parks and gardens should also be considered at feasibility stage.

Options must not be selected in isolation from the unique characteristics, significance, vulnerabilities and use of your specific requirements, and this may mean that different adaptive pathways apply to each site.[1] The worked example below is not based on a specific site and is illustrative only.



(illustration by Roger Worthington, Plan Vision)

(Response thresholds are most likely to be based on flood or storm events. These may affect land use, small-scale interventions, and assets and activity downstream from the targeted location of attenuated flow and other benefits for nature. The specific trigger points would need to be agreed by both the operations decision-maker and relevant consultants, and consultees such as the estate managers, tenants and rangers working at a site. Various permissions would be required and should be scoped out at the feasibility stage of any project.)

[1] Dynamic Adaptive Policy Pathways approach (Haasnoot, Kwakkel, Walker & Ter Maat)

Case studies, signposting and references

These case studies show adaptation in action and the approaches that have been tried out across properties in care in the UK.

Following a successful small-scale natural flood management intervention in Upper Calderdale, near the National Trust's Hardcastle Craggs property, a more ambitious project is being designed to reduce flood risk to downstream communities in Todmorden, Hebden Bridge and Marsden. Through nature-based solutions, the project will create around 7,000 leaky dams to provide erosion control alongside new woodland and peatland restoration to attenuate flow and groundwater.

Dunham Massey, a large National Trust property outside Manchester, is located on the River Bolin. The riverbank has breached in a number of places already. One large flood is likely to breach this artificial embankment completely. When this happens, it could create a new equilibrium for how the river behaves in this location and force a decision about whether to reinstate the flood defence as an earthwork, or create a new solution to naturalise the watercourse in this location. The image here shows upstream and downstream bank failure caused by upstream backwash scour and downstream erosion.

On the National Trust Holnicote Estate, a Riverlands project has been underway to re-profile sections of the watercourse. This will reconnect the river with its floodplain, and increase resilience of the landscape by blocking land drains and changing the grazing regime to encourage a wetter meadow environment and groundwater retention. Elsewhere on the estate, beavers have been introduced in a large enclosure and significantly changed the state of the watercourse by constructing woody dams and creating new wet woodland habitat.

A log secured to the river bed to attenuate flow, Upper Calderdale (© National Trust Images)

Banks on the River Bolin (© National Trust Images/ Stewart Clarke)

The beaver enclosure on the Holnicote Estate (© National Trust Images/Imogen Wood)

Signposting & other guidance of relevance/use

The National Trust has detailed case studies for our Riverlands projects which can be shared on request.

Nature Scot (Scotland's Nature Agency) provides user-friendly online guidance about **nature-based solutions.** Available at https://www.nature.scot/climate-change/nature-based-solutions

The Environment Agency (England and Wales) has produced detailed guidance on **keeping rivers cool,** available at https://www.ecrr.org/Publications/id/624

When considering change to rivers, there are likely to be many implications for the historic and natural environment, as well as access, drainage, flooding and infrastructure. Always **consult a historic environment specialist** (such as a curator and an archaeologist), a natural environment specialist (such as an ecologist) as well as planning consultants, engineers and your local statutory bodies to check the implications of any proposal. Most changes are likely to require planning permission.