National Trust

Climate Change Adaptation Guidance – Water

Water Features

Climate change vulnerability: high

Water features – introduction

Our green spaces and architectural designed environments are dotted and criss-crossed by water that is managed for both pleasure and purpose.

Water features encompass everything from natural water bodies to those that are completely artificial. These include ponds, lakes, small decorative features, fountains and impounded watercourses as well as ornamental streams, leats and races.

Water features are vulnerable to drought and heat in particular. These hazards directly impact water quality and scarcity. They are further compounded by surrounding land use, abstraction and the state of groundwater retention in the area.

Water features may be managed for a variety of reasons and objectives. They are often highly valued in historic and beautiful places for their recreational role and for their historic and designed significance. They also offer habitats in their own right and support wider habitats around them. Without water features, important natural and cultural resources could be lost, which are at the heart of the landscapes that we care for and value.

Water features also provide sinks in the landscape for sediment, carbon and nutrients, which can make them challenging to manage. Climate processes exacerbate these challenges and the scale and extent of impacts mean they often require a catchment-based approach. Smaller water features generally have smaller catchments (water that flows into them), and the smaller the catchment, the more easily it can be managed.

This guidance does not include wetlands, rivers and streams, which are covered in different sections and also in Natural England's Adaptation Guidance.[1]

Image credits:
Studley Royal and Fountains Abbey (© National Trust Images)

[1] Natural England's online adaptation guidance for many species, habitats and features (http://publications.naturalengland.org.uk/publication/5679197848862720)

Water features – why do they matter?

The original design intent of our gardens and parks often relies on the sight, movement and sound of water through the landscape. From the quiet pools of 20th-century flower gardens to the dramatic cascades of the Picturesque, people visit our historic and beautiful places to experience the combined view and feel of water, the built environment and the green space. Without water features, or if the water levels are reduced, the look and feel of the place is diminished; reflections are lost, water becomes de-oxygenated and aquatic life suffers.

The presence of water is recognised as something which enriches an experience, but also brings wildlife into the tamed garden space. Water features support habitats and species with a range of flora and fauna that would not otherwise be present.

Although water quality and ecological integrity are important for flora and fauna, they also need to be managed to support other properties of water features; for example, their aesthetic value in the landscape, odours associated with their experience and their use for recreational activity such as swimming.

Many historic parks and gardens integrate water management or include water features in their design. Frequently, the design is the reason for a site's inclusion on the Register of Parks and Gardens of Special Historic Interest, which means that the loss of a water feature can be detrimental to its significance. Significance can be enhanced by the cultural value of water features as the focus for paintings and poetry through the ages.

Water features dot the landscape and help document the evolution of land use over time, which deepens our understanding of a place. They also provide orientation in the landscape, which can be lost with their disappearance. Ghost ponds are those water features that can be traced on historic mapping but have since been filled in, ploughed out or abandoned and dried up.

In contrast, many historic dipping ponds in kitchen gardens have been rediscovered and put into use in recent decades. This excellent example of adaptive change is inspirational to the future management of water in designed gardens and parklands. Much of the water manipulation in gardens predates mains water and learning from past management is a good place to understand our water features and help inform future management.

Image credits:

Glasshouse and pond in the upper garden at Quarry Bank, Cheshire (© National Trust Images/James Dobson)

Water features – hazards, impacts and options

Hazard	Impacts	Options
Flooding	Structural damage, contamination (biological), overflowing	Design alterations to reservoirs (spillway upgrades, freeboard increase), design alterations to surrounding land to avoid impacts, natural flood management
Drought	Evaporation, low flows, less groundwater recharge, increased retention times (where water features impound a watercourse), interaction with water quality	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, restoration of associated infrastructure to avoid leaks, wetland creation upstream of water feature to help ground retain water ahead of summer months, increase the levels (seeking permissions where needed) through increase of freeboard, for example, to improve resilience during drought, increased groundwater retention capability
Shrink/swell	Structural damage, subsidence	Monitoring of water features (particularly dams and pool linings where clay has been used to build these), use adaptive windows (such as dredging interventions), consider the use of modern materials to increase resilience of dam and lining
Landslides/ coastal erosion	Structural damage, subsidence, saline intrusion	Preparation of emergency plans for dealing with water feature failure (particularly for larger water bodies and where these are considered to be medium–high risk), creating compensatory habitat (in response to coastal squeeze)
Heat	Algae (may result in closure due to health and safety), ecological impacts, increased recreational use (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 water features (particularly along south margin)
Repeat freeze-thaw action	Pipe damage, structural damage	Set appropriate standards for burying and insulating pipework if possible, map and understand your historic drainage networks
Storm rainfall and damage	Increased sediment loading, increased nutrient loading, overflowing	Land management changes targeted at water feature catchment, land use change in vulnerable areas, increased attenuation capacity (tree planting, natural flood management), moving access points, arable reversion

Water features – options and thresholds

Unlike buildings and landscaped parks, water features are often point in time interventions at historic places and connected to other features via the water they use or hold. Options for adaptation range from discrete alterations, which will help with water storage and efficiency, to measures that build resilience indirectly through changes in land use.

Specific options for adapting water features in the face of climate hazards:

Rainwater harvesting – where drought poses a threat to the visual and functional aspects of a water feature, using harvested rainwater can offset the reliance upon direct rainfall or water courses. Ideally, these should be set up for a big surface area so that they recharge in the light summer rainfall as well as in winter.

Reduce usage – this relates to how much water is consumed to retain the use/value of the water feature, but also relates to requirements and whether there is any way to flex these (e.g. less water-intensive flow, aeration options).

Design changes – these are likely to require associated consents, such as planning and drainage. An appropriate consultant to create any adaptive design change will be needed. For large water features, this may involve raising the crest and distance between crest and water level of a dam (the freeboard), or providing additional coping mechanisms (such as auxiliary spillways) for flood events that overwhelm the existing infrastructure, and may be driven by compliance. Siltation frequency compounded by rainfall intensity and run-off from fields and roads may need a combined approach of land use change and design interventions to prevent silt build-up at an unsustainable rate.

Nature-based solutions – increasing the ability of land upstream of a water feature to attenuate flow during flood events will help to protect vulnerable water features from damage and from being washed away during storm/flash flood events (e.g. tree planting, beaver dam analogues).

Land use change – the entry of nutrients and silt into water features is a significant problem, which can be compounded by heat and drought. This particularly affects online water features with artificial dams, but also any slow or static water body which 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.

Standards for works – appropriate standards for burying and insulating pipework should be set to ensure all changes/conservation works build resilience into existing features and protect them from freezing temperatures.

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)?

- Monitoring of levels within water features
- Algal bloom presence (which could be linked to levels of access, land use and waste water with high levels of phosphate and nitrates entering the water)
- Rate of siltation
- Compliance requirements (e.g. raised under a cyclical check on a statutory reservoir)
- Damage after a flood/storm event
- Frequency of drought affecting regularity of lack of functionality of feature (least regularly dry, dipping pools empty)
- Visitor complaints around how assets key to the visitor journey are experienced in climate extremes

Options and interventions are different for gardens and countryside

One option is to **do nothing** and another will be to maintain the water feature as it is. Sometimes, the built environment is not well maintained and the most effective approach to resist climate hazards and impacts, and improve the site's adaptive capacity is to **activate a regular maintenance regime.** Maintaining some water features is forever challenging, and sometimes they were not constructed with the long term in mind. Landscape changes contribute to issues with water features so we may need to think about broader changes to adapt our water features successfully. Any physical interventions may **require planning** permission.

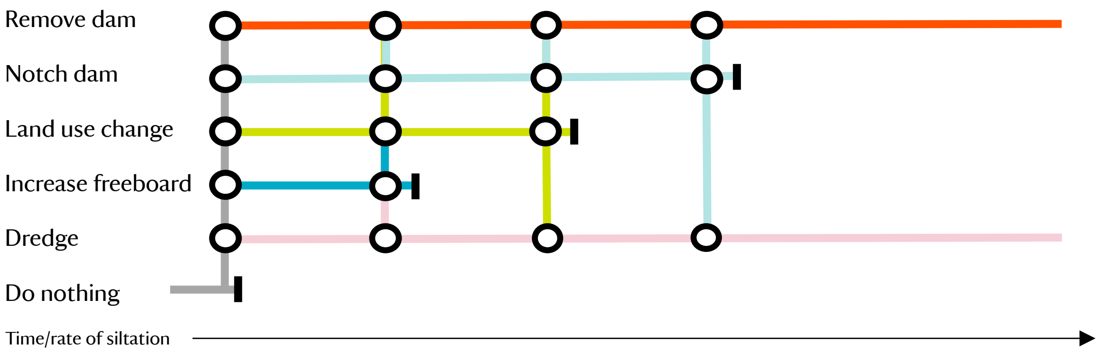
Water features – worked pathway example

This application of pathways and thresholds to a real site example shows how and when your adaptive response to climate hazards 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, archaeology, ecology, aesthetics and the historic environment. 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.

Although water features sometimes have a historic or current functional use, their origins are often rooted in the design intent and they are likely to be ornamental in the landscape. To avoid harm to the historic environment, **significance** should always inform the approach, but this must be weighed against public benefit and sustainability in the face of a changing climate.

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 based on the increased rate of siltation of an online lake.



(Response thresholds are most likely to be based on siltation levels, linked to the experience of visitors, statutory monitoring and/or impacts of siltation on designated features (such as SSSI or a designed landscape). The specific trigger points would need to be agreed by both the operations decision-maker and relevant consultants, and consultees such as rangers working at a site.)

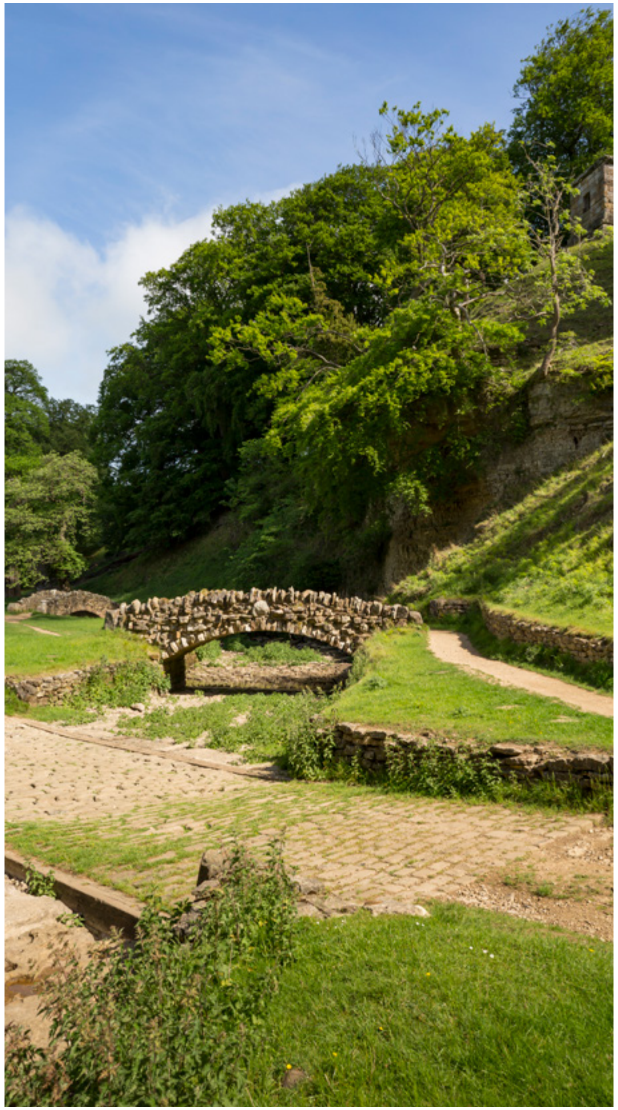


Image credits:

This image shows the Seven Bridges Valley at Studley Royal water garden in drought, but the site also suffers from severe flooding and storm events. A project is underway to slow the flow of water upstream to relieve pressure on the water garden and other features affected by these climate hazards (© National Trust Images/Chris Lacey)

[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.

At Mottisfont, the 2022 drought caused the watercourse, which supplies the key garden feature of the font, to dry up and stop flowing. This has a direct impact on the significance of the place in terms of how it was designed to be experienced. With the absence of flow and the sound of water, the impact of drought threatens fundamental heritage values of the designed landscape. There is also an impact on aeration and habitat.

Mottisfont dried-up water course
(© National Trust Images/Keith Sinclair)

Arlington Court in Devon, National Trust, has an online reservoir that has silted up in less than 10 years since the previous large-scale dredge. This rate of siltation is unsustainable and the associated maintenance is damaging for both environmental impacts and ecology. Despite its sensitive location in a Registered Park and Garden, the difficult issue of future management needs a multi-disciplinary team of stakeholders to consider options outside the status quo.

At Charlecote, National Trust, the main lake suffered considerably in the 2022 drought and almost entirely dried up, with significant impacts for wildlife, aesthetics and visitor experience.

Charlecote lake, dried out in the drought of 2022
(© National Trust Images)

At Kedleston, National Trust, the water quality in the lakes initiated a catchment-wide project using farm advice to address land use practices that were causing these issues.

At Westbury Court Dutch Water Garden, National Trust, flooding caused damage to the garden. The consultancy and property teams completed a project to create a bypass channel to prevent this hazard from repeatedly impacting the garden.

The National Trust's Studley Royal and Fountains Abbey site suffered severely from flooding in January 2021 and then from drought in the summer heatwave of 2022. The site is focusing on flood attenuation and improving the ability of the wider Skell catchment to retain groundwater upstream of this World Heritage Site to adapt to climate extremes.

Studley Royal and Fountains Abbey (© National Trust Images)

Signposting & other guidance of relevance/use

Water UK provides detailed technical guidance on asset management planning in the face of climate change, among several other informative guidance topics on water efficiency. https://www.water.org.uk/guidance/asset-management-planning-climate-change/

When considering change to designed water features within gardens and parks, or associated with historic places, such as fountains and pools, always **consult a historic environment specialist**, such as a curator and an archaeologist, and an ecologist to check the implications of any proposal.

Changes to water bodies, such as lakes and canals, will almost certainly require planning permission and other consents. Consulting a planning adviser and a civil engineer will be essential in this process.