Part 6
Access and recreation

Introduction

This chapter describes the potential direct and indirect impacts of climate change on a range of public access resources, and outlines possible adaptation responses available to those involved in their management.

Recreation in the natural environment, whether through organised sports and events or more informal activities, is important for our health and quality of life, and in sustaining local and national economies. *The Monitor of Engagement with the Natural Environment Headline report from the 2015-16 Survey* (Natural England 2017a) estimated that there were 3.1 billion visits to the natural environment in the recording year March 2015 to February 2016, including 1.35 billion to the countryside, 0.32 billion to the coast and coastal resorts, and 1.45 billion to urban greenspace. These visits included 519 million visits that took place using access networks, i.e. paths, cycleways and bridleways. *The 2019 Monitor of Engagement with the Natural Environment (MENE) Headline Report* (Natural England 2019) indicates that more people are visiting the natural environment than ever before, with numbers having increased since 2015/16.

Access to the environment is very dependent on physical infrastructure like footpaths and cycle paths, parks, and accessible areas such as greenspace and open access land. These resources are likely to be affected significantly by the effects of climate change, for example by more frequent incidences of high rainfall and flooding, erosion inevitably creating issues for future maintenance and visitor management. Patterns of recreational use are also likely to change in response to changing climatic conditions, which could create pressures on other resources such as protected wildlife sites and species.

Climate change will impact on access resources in all parts of the country, but is likely to be more of a concern in areas that experience extreme weather events and/or where change is more rapid, such as on eroding coastlines and in the uplands, and in areas with high visitor pressure. However, McEvoy *et al* (2008) note that the relationship between climate and wider visitor demand is complicated and that 'climate influence on visitor behaviour is more likely to be overshadowed by socio-economic trends.' MENE data too indicates that while weather is significant in determining people's recreation decisions, other factors such as available time and income are just as, if not more, significant.

Access and recreation resources

Public access and recreation resources on land and water can be broadly divided into **linear routes** and **areas**. These are described briefly below:

Linear routes

Public Rights of Way (PROW)

PROW are routes upon over which the public has the legal right, depending on the type of route, to walk, ride a horse or bicycle, or drive a motor vehicle. There are about 186,000 km of rights of way in England, which represents about a third of the total highways network. This network provides the crucial linear infrastructure for accessing much of the natural environment.

Paths can have firm sealed surfaces, unsealed surfaces (such as an aggregate material) or, as is the case with most rural paths, will be unsurfaced. Public rights of way are generally managed by local highway authorities, who have a duty to maintain and keep them open for the public to use. Landowners also have legal duties associated with PROW, including ensuring that they are not obstructed or overgrown.

National Trails and other promoted routes
There are several types of promoted route in England, including the statutory National Trail network and England Coast Path (which will also correspond in many places with existing PROW), longer promoted routes such as the Coast to Coast path and many shorter local and regional trails. The National Trail network alone is 4000 km long, and the England Coast Path, when completed, will cover 4500 km and have associated accessible areas by virtue of its coastal margin. Both are managed largely by partnerships led by local authorities.

Cycle routes
Many cycle routes have been established along the routes of disused railway lines or on forest tracks, and will generally have some sort of improved surface, though this could be sealed or unsealed. The National Cycle Network, co-ordinated by Sustainable Transport (British Cycling Organization) (SUSTRANS) provides over 22,000 km of on and off-road routes. Many cycle routes have shared use with walkers, wheelchair users, and sometimes horse riders.

Permissive routes
In addition to statutory rights of way, walking and riding routes can be provided voluntarily by individuals or organisations. Provision can be small- scale, involving individual land-owners and often as part of an agri-environment scheme agreement; or larger and more formalised, as is the case with most of the 3200 km canal towpath network managed by the Canals and Rivers Trust.

Rivers and canals
Rivers and canals are important for various water-borne activities such as fishing, swimming and boating, and river banks and towpaths provide valuable open space and access routes. However, there is no right of navigation or public access to banks on most rivers.

Areas

Areas for public access and recreation range from small scale urban and country parks and more informal green spaces, to large tracts of statutory open access land covering many square kms.

Open Access land and other open access rights
The Countryside and Rights of Way Act 2000 (CROW) created a general right of access on foot to almost 12,000 km^2 of land mapped as: mountain, moorland, heath and down. (**Rights of Way and Accessing Land**) Access rights also exist on the various types of common land and on land dedicated under CROW by private land owners and public bodies, including the Forestry Commission, which has dedicated its freehold woodland estate, and Natural England, which has dedicated suitable National Nature Reserves. Access rights under CROW also apply to the margin of the England Coast Path. Whilst the majority of rights are on foot, access rights can include higher rights, particularly for horse riders.

Nature Reserves
Nature reserves, including statutory **National Nature Reserves** (NNRs), Local Nature Reserves (LNRs) created by local authorities, and sites managed by conservations bodies such as the RSPB, National Trust and Wildlife Trusts, are generally managed for public access as well as conservation. Nature reserves cover a significant area of England, with NNRs accounting for over 94,000 ha and LNRs nearly 40,000 ha. Much of the public access to nature reserves is via the linear routes mentioned above, but some are open access.

Urban and country parks

There are various types of park, ranging from more formal, urban parks to less formal 'managed' countryside found in country parks. Parks are important, both for providing accessible greenspace in urban areas close to where people live, and for providing popular destinations further afield, often at the interface of town and countryside. England also has extensive areas of private parkland, often as part of landed estates, with varying degrees of public access.

Greenspace

Greenspace Scotland defines urban greenspace as, 'any vegetated area of land or water within or adjoining an urban area'. It forms an important part of the green infrastructure of towns and cities and can include parks and gardens, informal recreation spaces, domestic gardens, village greens, urban commons, and areas of natural and semi-natural open space. It also includes green corridors, e.g. rivers and canals (including their banks), road and rail corridors, cycle routes and pedestrian paths. Natural England, in **Nature Nearby** (2010), adopts a broad definition and identifies *natural greenspace* as 'places where human control and activities are not intensive so that a feeling of naturalness is allowed to predominate' and *accessible greenspace* as, 'places that are available for the general public to use free of charge and without time restrictions'.

Greenspace is managed by a range of bodies, including local authorities, community groups, charities, and wildlife trusts. Some greenspace may not be managed at all, but can still provide informal access and recreation opportunities for urban populations.

Coasts and inland water bodies

Coastal areas are a focus for recreational activities based on and along the shoreline, including visiting beaches, coastal resorts and beauty spots, walking on coast paths, the use of sea-cliffs for climbing, and coasteering. Offshore and near shore activities will include sailing, angling, surfing/sail-boarding, jet-skiing and scuba-diving. Lakes and reservoirs are also often focal points for recreational visits and activities.

Potential climate change impacts

This section outlines the potential impacts of climate change on recreational sites and routes and considers the critical factors that are likely to exacerbate or mitigate these impacts.

Scottish Natural Heritage (2011) identified two main types of pressure on access resources: *chronic pressure* from ongoing climate trends and *acute pressure* from extreme weather events. These in turn will translate to widespread and more predicable *chronic impacts* and less predictable, more localised *acute impacts*.

Impacts on access resources can also be *direct* or *indirect*. Direct impacts will commonly include the immediate effects of physical conditions and process, i.e. the effects of weather, weathering and subsequent erosion. Indirect impacts include behavioural responses to climate change, such as changes in recreation patterns or changes in land use, and their impacts on access resources. The following table summarises the likely impacts of projected climate change on recreation areas and routes. These are discussed in more detail in the subsequent paragraphs.

Cause	Consequences	Potential Impacts	
		Linear routes	Areas
Longer, warmer and drier summers	■ More frequent periods of drought ■ Drier vegetation, leading to increased risk and severity of wild fires. ■ Longer growing seasons, leading to increased vegetation growth. (Potentially more flammable vegetative material for wildfires.) ■ Changes in visitor behaviour in response to milder winters, hotter summers, and an extended warm season, potentially leading to more outdoor visits and an increased use of some recreation routes and areas. ■ Reduced water levels in rivers, streams, lakes, and reservoirs. ■ Increased risk of blue-green algae.	■ Path surfaces are more likely to break up and erode, due to desiccation. ■ Paths are more likely to become overgrown, and will become less attractive to users if they are blocked or difficult to use. ■ More frequent maintenance may be needed by Highway Authorities, National/ Coastal Trail partnerships and landowners to keep routes open and comply with legal obligations. ■ Visitor pressures on sensitive wildlife sites may increase at peak times and over an extended warmer 'visiting' season, increasing the risk of physical damage or disturbance ■ Access to some rivers, streams and lakes for some forms of water-based recreation may be restricted, potentially placing more pressure on available sites.	■ More frequent closures/restriction on Open Access land due to fire risk. ■ Parks and other more formal areas of open space may need to be mown more frequently (although not during droughts). ■ Visitor pressures on sensitive wildlife sites may increase at peak times and over an extended warmer 'visiting' season, increasing the risk of physical damage or disturbance, especially coastal sites (Simpson 2013).
Milder winters and higher winter rainfall	■ Increased rainfall and run-off could lead to soils becoming saturated. ■ Saturated soils more prone to surface damage ■ The frequency and magnitude of flood events is likely to increase. ■ Water levels in some water bodies may increase. ■ Less erosion in winter months due to reduced frost heave.	■ Higher rainfall and more intensive rainfall events are likely to cause more frequent and extensive erosion of routes, making them more difficult to use particularly for less physically able users and for longer periods ■ More erosion material could be deposited on routes, causing obstructions and requiring more work from highways authorities and landowners to keep surfaces clear. ■ If paths become more difficult to use, users may divert around muddy or waterlogged areas, which could affect surrounding land and have negative impacts on user enjoyment, farmland and biodiversity. ■ Paths would be more prone to damage from farm traffic, recreational motor vehicles, horse riders and other users. ■ Greater need for path surfacing to allow for the passage of the ordinary traffic of the neighbourhood ■ Flooding and erosion could damage or destroy waterside paths and restrict their use, and could lead to permanent loss of public rights of way. ■ Higher water levels could lead to increased risks to public safety, particularly on riverside paths. ■ In some upland and exposed areas, less management and repair of path surfaces may be required.	■ Flooding could cause a reduction in the area of accessible land within open access land and parks. ■ Wetter areas such as bogs and marshes may become unusable.

Cause	Consequences	Potential Impacts	
		Linear routes	Areas
More frequent extreme weather events,	■ More frequent and more severe periods of high winds and intense rainfall, leading to storm damage, flooding and rapid water-logging of soils ■ More frequent droughts and extreme heatwaves: ■ Increased health risks from extreme heat and associated higher pollution levels	■ More frequent flash floods, caused by overland flow exceeding the infiltration capacity of the soil, will result in more acute erosion/deposition events. ■ Obstruction and acute physical damage to paths, caused by falling trees in woodland areas and debris transported by flooding/ overland flow, will have an impact on maintenance regimes and costs. These impacts will be difficult to predict, and managers will have to be prepared to respond urgently to unforeseen events. ■ Low water levels in navigable rivers/ waterways may entail low flow restrictions for craft ■ Rapid desiccation of soils could result in damage to path surfaces. ■ Participation in more physical outdoor activities may put participants at risk of heat and pollution related health issues (heatstroke, sunburn, breathing issues, exposure to toxic algal blooms in lakes etc.)	■ Water-logged areas could become less attractive and unusable for visitors ■ Damaged infrastructure could lead to a long-term reduction in tourist revenue to local communities and business. ■ Remedial flood defence work at coasts and along watercourses may affect the quality and extent of public access, but may also provide opportunities for new access, e.g. on flood banks and at managed retreat sites. ■ An increased fire risk could lead to access restrictions ■ Prolonged hot weather could lead to greater use of inland waters and coastal areas water resources.
Rising sea levels and more frequent storm surges	■ Rising sea levels and more powerful waves will lead to increased rates of coastal erosion, particularly on unprotected soft coasts, resulting in more severe cliff retreat and a loss of beaches and dune systems. ■ More frequent storm surges and subsequent flooding will affect low-lying coastal areas and associated access resources.	■ Coastal paths will be at greater risk of erosion and are likely to require more frequent maintenance. Where the coastline is unprotected they could be lost altogether as the coastline retreats landwards. Paths without the capacity to be re-located further inland could be lost permanently. ■ The **England Coast Path** is being established with the facility for 'roll back' as the coast changes, but accelerated erosion rates due to climate change could necessitate ongoing higher repair and general maintenance costs. ■ Increased erosion could increase the risk of accident for coast path/margin and beach users.	■ Effects on beach areas and profiles can alter access to beaches and the available space for visitors. ■ A higher risk of subsidence and rock-fall at coastal cliffs can increase risks to beach users, coastal walkers and climbers. ■ Any reduction in the area of coastal habitats and sites of high biodiversity value could result in higher visitor pressures at remaining sites. ■ Chronic, long-term changes may affect the overall character of destination areas with possible changes in visitor numbers and behaviours.

Longer, warmer and drier summers

Warmer and more 'reliably warm' summers may lead to more people holidaying at home than abroad (Giles & Perry 1998). Coombes and Jones (2010) note that climate change is likely to lead to an increase in the vulnerability of many sensitive environments and that this vulnerability may be exacerbated by increased visitor pressure as a result of warmer, drier weather. This effect is likely to be most noticeable at coastal sites where increases in popularity, combined with potentially reduced land area due to sea level rise and increased erosion, can deplete the resource itself and thus impact on habitats and species such as shore bird populations via increased disturbance and reduction in available space.

Longer, warmer and drier summers may result in more people visiting the outdoors over an extended 'season', and bring with it increases in pressure on available recreation and access resources. Greater use of path networks will put more pressure on surfaces and increase subsequent erosion risk, which, combined with greater use of associated access furniture (i.e. gates, stiles, bridges etc.), will put more pressure on maintenance regimes and budgets.

Higher temperatures and an increased incidence of drought are likely to result in the drying-out of vegetation and increase the risk of wildfires, particularly in vulnerable areas of grass and heathland which also attract a lot of visitors. Wild fires will impact on species and habitats (as discussed elsewhere in this manual), and the increased risk of wildfires could lead to more frequent closures of open access land. Public rights of way are not affected by access land restrictions, but permissive paths may be shut.

Desiccation of soils during hot, dry periods may lead to soil loss and subsequently result in damage to unsealed path surfaces, particularly if combined with stronger winds.

Warmer, drier conditions could lead to increased use of coastal areas, with greater numbers visiting coastal resorts and beaches (Coombes, Jones & Sutherland 2009; de Freitas 1990) and a corresponding increase in water-based activities (Simpson 2013). Increased visitor numbers will potentially put pressure on associated habitats such as sand dunes and coastal marshes, with potential increases in disturbance and trampling. An increase in water-based recreation may impact on coastal and marine sites, with disturbance to seabird and marine mammal populations (Natural England 2012).

Inland, visits to rivers, lakes and reservoirs may increase, with similar pressures on associated recreational infrastructure and adjacent habitats. However, reduced water levels may prevent the use of some water bodies (Defra 2014) and lead to more pressure on unaffected sites. A reduction in precipitation may also lead, directly and indirectly, to an increased risk of eutrophication and the development algal blooms developing in inland water systems with associated health risks to recreational users. (Note - this may also be a consequence of higher winter precipitation and/or summer storms (Defra 2104)).

A longer annual growing season may result in greater vegetation growth, with paths and access areas becoming more overgrown and needing more frequent cutting/weed control from relevant managers and landowners (Scottish Natural Heritage 2011). Grazing regimes may also need to change, this may also affect access, especially for people with dogs. This may deter people from using some public rights of way, with consequences for people's health, enjoyment and local visitor economies, and could put pressure on available management budgets.

Higher winter rainfall

Increased precipitation and associated run-off could lead to saturated soils and associated flooding and erosion of path surfaces (Scottish Natural Heritage 2011). Where material has been eroded from surfaces, paths could become more difficult and dangerous to use and the repair of damaged paths will put additional pressure on managing authorities' maintenance and repair regimes. Physical loss of paths and associated infrastructure will reduce the availability of path networks and may reduce tourism income, which could be felt particularly in areas where walking and riding are important to the local economy. Erosion will also lead to the deposition of eroded material elsewhere, which could necessitate its removal from other areas. Erosion of path networks may also have subsequent impacts on surrounding protected sites as people divert around waterlogged areas or inadvertently create more erosion within fragile habitats.

Erosion of coastal or riverside routes can result in the complete loss of a path since public rights of way are fixed to a specified, legal route. Consequently, unless a suitable alternative route can be found or a new route created, both of which could be expensive to implement, the network could be permanently depleted.

Upland routes, especially those on steep slopes and with fragile soils, and where there is intense visitor pressure, are particularly vulnerable to erosion damage because of the generally high levels of precipitation (rain and snow) they experience. The potential for erosion will increase if overall precipitation, or the intensity of precipitation, increases. This will have implications for management and maintenance. However, warmer winters may also result in fewer freeze-thaw cycles (which are more significant in upland areas), which may mean less erosion from frost heave.

Milder winter periods may also serve to extend existing visit/recreational activity beyond the 'traditional' activity periods, which in turn could lead to more constant visitor pressure on routes and areas. However, this could also serve to even out visitor pressure over the course of a year. When combined, more visits during the period when water levels are at field capacity will result in increased wear of path surfaces resulting in more muddy paths, particularly in areas where users congregate at stiles and gates. This will vary according to soil type and underlying geology and hydrology.

More frequent extreme weather events

Distinct events such as heatwaves, flooding and drought are predicted to become more severe due to climate change and will potentially bring increasing challenges for recreation management since the scale and unpredictability of such events makes them more challenging to plan for and manage than more expected seasonal events.

More frequent and intense storms are likely to increase the risk of wind damage to routes and sites, with fallen trees and other debris needing to be cleared if paths and spaces become obstructed or dangerous for public use. Extreme and unpredictable weather events could also present a safety hazard for visitors, particularly in exposed, upland and coastal areas, and additional work could be needed to ensure the safety of structures such as bridges and walkways where these are provided as a visitor management measure e.g. on nature reserves, promoted routes etc. These less predictable events will inevitably make it challenging for access managers to plan ahead.

Rising sea levels, coupled with more frequent storm events will exacerbate coastal erosion, potentially resulting in shoreline retreat and loss of beaches. Coastal routes may be damaged and, if they do not have the capacity to vary or roll back, may be permanently lost or made unsafe, necessitating repair or replacement. An increased risk of rock-falls on eroding cliffs will also have safety implications for beach users and for activities such as rock climbing and coasteering. More frequent, and perhaps more widespread, inundation of lower lying areas as a result of storm surges will create similar issues to other forms of flooding and could result in permanent land use change and potentially loss of access due to erosion/infrastructure damage.

More frequent extreme flood events in general will, like more seasonal flooding, cause physical damage to routes and areas as well as interruptions to network use via inundation and subsequent waterlogging, but the scale and unpredictability of occurrence will exacerbate their effect. Caving systems are susceptible to seasonal and periodic flooding, depending on a system's hydrological characteristics and rainfall events. More precipitation in general may make some caves less accessible, and more frequent heavier rainfall events may increase the incidence of flash flooding and the obvious risks to cavers/visitors associated with this.

Similarly, extreme droughts and heatwaves will mirror the general risks associated with hotter, drier summers, such as higher fire risk and the desiccation of surfaces, but more acute conditions and the unpredictability of such events will exacerbate their impact.

Extreme heatwaves increase the risk of associated health issues such as heatstroke and respiratory problems related to increased pollution levels. This will have implications for health services provision, but will also affect people's decisions and behaviours about where to go and what to do. Perry (in Hall (2005) p86) observes that: 'For many sporting and leisure activities there are critical thresholds beyond which participation and enjoyment levels fall and safety or health are endangered.' Perry also noted that in the European heatwave of 2003, extreme heat levels led to a range of behaviours including tourists abandoning planned visits, but also more people in urban areas going to the countryside to try and escape higher heat and pollution levels.

Location and physical characteristics

The vulnerability of a site or route to the impacts of climate change will vary according to its location and physical characteristics.

The landscape and topography within which a recreational route or area is located will influence its exposure and vulnerability to the impacts of climate change. For example, paths and areas in the uplands will tend to experience more extreme weather, and will often be located on steeper slopes and thinner soils. Consequently, they are likely to be more vulnerable to the effects of weathering and erosion than those in lowland areas. Low-lying areas may be more susceptible to waterlogging and flooding, and routes and areas on the coast will be more at risk from coastal flooding and erosion associated with sea level rise.

Local physical features along the length of a route or within an area will also be important.

These include:

- the degree of slope along a path - longitudinally and in cross-section;
- the amount of shading by vegetation along a route, which can affect rainfall interception and exposure to other weathering agents;

- the amount and type of surface vegetation cover. This will influence the cohesion of the surface, runoff characteristics and susceptibility to precipitation, desiccation and frost action.
- The proximity and hydrological behaviour of wetland features such as rivers, streams and marshes/bogs will influence how much of a route or area is susceptible to waterlogging or erosion.
- The severity of weathering and erosion to a route or site will also be influenced by the composition of the surface material and its underlying soil type.

Surfaces will have varying degrees of soil exposure depending on whether they are sealed or unsealed and how well consolidated or permeable the substrate is. Many paths will have some form of drainage such as parallel ditches, cross-drains and culverts, depending on the level of management and their susceptibility to waterlogging. Where drainage can be managed, the risk of surface degradation, flooding and erosion may be reduced.

Public access, biodiversity and climate change

Most nature reserves, and many other sites of high biodiversity value, will have a degree of public access, depending on their location, ownership, management objectives and legal obligations. Many sites, including Natural England's National Nature Reserves, RSPB reserves and many Wildlife Trust sites, are actively managed for both wildlife and visitors, while others may be managed primarily for conservation or some other purpose, but will nonetheless have some form of public access via public rights of way, open access land, paid for or permissive access arrangements.

The potential effects of climate change on habitats and species are discussed elsewhere in this manual. In many cases, these impacts will bring management challenges, and these challenges are likely to be compounded if climate change results in significantly increased visitor pressure or changes in visitor behaviour.

Natural England's Recreation and Disturbance Theme Plan (Natural England, 2015a), compiled as part of the Improvement Programme for England's Natura 2000 Sites (IPENS), noted that recreation patterns were likely to alter with changing climatic factors such as higher temperatures and more rainfall, and observed that,

'The disturbance effects of public access may also alter as a result of climate change on some sites. For example, where coastal squeeze is causing a reduction in the area of habitat available for some features (such as is being seen with nesting habitat for little terns), disturbance effects may increase even if the number of people using a site does not change. This can be because use of the site may be concentrated in a reduced area.' (p11)

Climate change may also increase the number of invasive species which can persist in the UK and movement of people is one of the ways some of these spread. For example, the **Pirri-pirri bur** has been identified as being easily spread through attachment to human clothing and would benefit from a warmer climate (GB Non-Native Species Secretariat 2015).

The effects of climate change on habitats and species can be predicted and planned for to a certain extent, but changes in people's behaviours and actions in response to climate change are more difficult to predict, especially in relation to specific sites.

The Natural England **Monitor of Engagement with the Natural Environment** summary reports for years 1- 4 included data on motivations and barriers to accessing the natural environment. While weather seems to be a factor influencing people's use of the natural environment, it is more likely to be a contributory factor compared to other influences so it is difficult to say with confidence how people's behaviours will change in response to a changing climate, when thinking about specific sites. McEvoy *et al* (2008) note that 'the relationship between climate and visitor demand is complicated', and that 'climate influence on visitor behaviour is more likely to be overshadowed by socio-economic trends'. However, there seems to be confidence that if higher summer temperatures become more common, then this will lead to increased visitor levels, particularly at the coast, and more participation in marine/coastal based activities such as beach visits and water-sports (Coombes, Jones & Sutherland 2009).

Balancing the needs of visitors and the management of protected sites and species within the context of a changing climate will clearly present a range of management challenges if the benefits of recreation and the necessity of protecting the conserved resource are to be realised. This will rely on informed management practices based on good evidence and the flexibility to apply that management on a site basis.

Potential adaptation responses

This section provides an overview of some of the main issues in adapting recreation routes and sites to climate change. Adopting resilient designs and being flexible to developing conditions when planning new provision or adapting existing resources will be a key approach to adapting to future demands.

Design and materials

The behaviour of a route surface in response to natural and human weathering agents is critical to its resilience. The choice of materials, whether the surface is sealed or unsealed, profile design and camber, and construction methods, will be important considerations when planning new paths or for the maintenance and repair of the existing network, in response to predicted levels of use and changing environmental factors.

Choosing resilient materials and designs may incur higher costs but these will need to be considered alongside long-term performance and resilience in response to changing conditions. The use of boardwalks or flexible bonded surfaces, for example, may be the best option for areas likely to be permanently or frequently wet. The choice of materials used will also be a consideration however, as other environmental impacts, e.g. micro-plastics in the environment, will have to be considered.

Drainage

The performance of any associated drainage is vital in the creation and maintenance of path networks, and planning resilient drainage will clearly benefit from a good knowledge of local hydrological characteristics of a site or area. Knowledge can be gained from observing the previous behaviour of a site or route's drainage under varying conditions, seeking advice from authorities or organisations that manage access in areas that see higher rainfall and/or more extreme weather events (e.g. upland areas), and obtaining expert assessments through hydrological surveys and modelling.

As well as assessing the effects of rainfall and flooding on routes themselves, the hydrological impact of a path or path network on local flood management may have to be taken into account since there is evidence to suggest that paths can accelerate water transfer downslope and exacerbate flooding (Cumbria Floods Partnership 2016).

Designing for resilience should aim to build in the capacity to cope with both current and projected future levels of precipitation and run-off, to provide, as far as possible, a buffer to cope with greater volumes of water and more frequent rainfall and storm events. This may often involve simply creating larger and more numerous drains and culverts, and using more robust materials. It may also be possible to design footpath drainage to have a beneficial impact on adjacent biodiversity, i.e. diverting water in to green infrastructure beneficial for biodiversity (See chapter 4).

Access furniture

Structures such as stiles, gates and benches are vulnerable to damage from flooding and fire, and foot/bridle bridges in particular are often in the front line during flood events. When planning for new provision or replacing existing structures in vulnerable areas, adopting more resilient designs and materials will help to increase overall resiliency of the resource.

For example, increasing the span or height of foot path and bridle path bridges can enable them to withstand periodic high flows, (e.g. SUSTRANS 2015 Ch 8; Scottish Natural Heritage 2011), but larger structures can be very costly to install. Moving structures to less vulnerable locations may also be possible.

Route location

Although re-routing a footpath or bridleway may be a pragmatic response where it is at risk, most access networks will comprise public rights of way, and any change to their route would entail going through a legal process to obtain a diversion or closure, or in the case of National Trails, a variation process requiring approval by the Secretary of State for the Environment. This can be impractical, expensive and time consuming. However, if long-term resilience is dependent on relocating part of a route, for example away from a watercourse or stretch of coastline that is vulnerable to erosion or flooding, then this should be considered.

As has been noted above, the England Coast Path can adapt via its roll-back provision and identifying optional alternative routes when the 'ordinary' route may be unavailable due to erosion, flooding etc.

A certain amount of network loss will be inevitable as paths are either destroyed completely, or prove impractical or too expensive to protect or move. However, accepting this and allowing natural processes to take their course, can allow landscapes to develop naturally and, if it is an option for access managers, working with these processes means that benefits and savings may still be realised without compromising overall public benefit. Clearly there will be a difference here between definitive routes where there is a duty to keep them open and usable and permissive or non-definitive routes needing no legal mechanism to close or divert them.

Adaptation to flooding could involve:

- Diverting or closing rights of way if they are lost or become unusable.
- Use of seasonal Traffic Regulation Orders to adapt to waterlogging/flood conditions.
- Use of voluntary restrictions to access during impassable/recovery conditions.
- Provision of targeted recreational information and education about areas and times to avoid visiting when flooded or at risk of being flooded.
- Identifying more resilient routes within a vulnerable area and negotiating alternative/new permissive and/or statutory access.

Management and maintenance regimes

Maintenance regimes will necessarily have to adapt to changing climatic impacts. The nature of the work involved and the frequency of those works will need to reflect changing environmental demands, for example more frequent cutting of encroaching and surface vegetation, and more regular inspections of path surfaces and drainage.

Scottish Natural Heritage observes that, 'In common with other aspects of the 'transport network', the key issue for adapting to climate change is effective maintenance. Therefore regular (which may or may not be frequent) small- scale maintenance is likely to arrest the deterioration of paths that would be susceptible to the 'magnified' effects of the climate compared with current conditions – i.e. helping the path to cope with chronic effects. Where it becomes apparent that particular features or sections are failing repeatedly the option should be taken to re-evaluate the specification rather than replace / repair like-for-like.' (Scottish Natural Heritage 2011 p27).

Statutory provisions for adaptation

In some instances, adaptation for access and recreation will involve a statutory process, or will be underpinned by legislation. Examples of statutory provisions relevant to climate change adaptation include:

Changes to public rights of way

As mentioned above, relocating a public right of way may be considered where public use and enjoyment is threatened, and while the legal process is often costly and time consuming it will usually be preferable to losing a route altogether. There may also be opportunities to create or dedicate new routes and considering future climate change resiliency, whilst not a statutory requirement in current highways will be advisable in planning future provision. Such changes could be planned as part of a Rights of Way Improvement Plan (ROWIP) – see section on ROWIPs below.

SSSI diversion orders

SSSI diversion orders are now a provision under the 1980 Highways Act, and allow certain public rights of way to be re-routed where on-going use of a right of way is causing damage to the features of the protected site. Climate change may intensify potential conflicts between public access and nature conservation, and therefore conservation bodies and access authorities should be aware of the potential for using SSSI diversion orders for securing both conservation and public access benefits. Further information on the use of SSSI diversion orders can be obtained from Natural England.

England Coast Path roll-back

The England Coast Path is a long-distance National Trail which will, when completed in 2020, gives people a right of access around the entire English coast. The Coastal Access Scheme includes a 'roll back' provision, so that if a section of coast erodes the path can be moved progressively inland (without lengthy referral processes) and also has the option, where appropriate, of identifying alternative routes. The ability to move the route of the path in response to shifting coastlines ensures that a measure of climate change resilience is being built into its design. As noted previously, other public rights of way do not enjoy this provision and where they succumb to coastal or river bank erosion they can be lost for good. The England Coast Path is included as a case study later in this chapter.

Countryside and Rights of Way act (CROW) restrictions on open access land and the England Coast Path

Under the provisions of the CROW Act, landowners can apply to relevant authorities (Natural England, the Forestry Commission and the National Park authorities) to close land for the purposes of land management, nature conservation, fire prevention, or public safety. Natural England has published **guidance** on the use of such restrictions. These provisions are potentially helpful in responding to some climate change impacts, particularly in times of drought where the risk of wild fire is high, or where continued public access would pose a risk to wildlife. Because open access land often coincides with areas of high biodiversity value, these areas can be vulnerable to excessive visitor pressure. Guidance for land owners responsible for managing **Open Access Land** and the **England Coast Path** has been published by Natural England (2014, 2015b).

Rights of Way Improvement Plans (ROWIPs)

ROWIPs are strategic documents drawn up by highways authorities as a requirement of the Countryside and Rights of Way Act 2000. They aim to assess and improve an authority's rights of way network and are required to be reviewed at no more than 10 year intervals. They are usually linked to the relevant Local Transport Plan (LTP), which sets rights of way within the context of an area's wider transport network.

The impacts of climate change are now an important factor to be considered in the maintenance and development of an authority's rights of way network and should be an integral part of any planned improvements. The renewal of a ROWIP is a good opportunity to include an assessment of, or make provision for an assessment of, climate change, particularly since ROWIPs and LTPs can work over long time frames.

Considerations could include:

- Assessing the current public rights of way network for climate change vulnerability and changes since the last ROWIP, and assessing risks as above.
- Identifying the impact of climate change on users' enjoyment of the network and how recreational behaviours may be affected by a changing climate, for example increasing usage and greater demands on the network.
- Ensuring that new provision is, as far as possible, future-proofed for a changing climate.

Local Access Forums (LAFs) also have a key role in monitoring local public rights of way and providing input to ROWIPs and ROWIP reviews, and could usefully consider the impact of climate change on their areas.

Summary of potential adaptation options

Climate change impact	Potential adaptation options	Possible issues
Waterlogging and erosion of path surfaces	■ Use existing techniques and standards for path drainage, but higher specifications may need to be used and maintenance regimes for the clearance of ditches and culverts etc. may need to be revised. ■ Adopt more resilient surfacing materials and construction techniques. ■ Re-model path profiles to encourage better drainage. ■ Use England Coast Path (ECP) roll-back and optional alternative routes. ■ Where possible, reposition paths to minimise waterlogging and erosion. ■ Install larger drains/culverts to cope with potentially large scale and longer-term water-logging events. ■ Install boardwalks if drainage is impractical in wetter areas, or if drainage is not possible without damaging areas of important wetland habitat. ■ Manage visitors to divert them away from sensitive areas, either temporarily or longer term. ■ Targeted tree/shrub planting to help reduce erosion/runoff e.g. upslope from vulnerable paths. ■ Incorporate water management and biodiversity gain in adaptation actions where appropriate.	■ Any improvements to drainage or new drainage infrastructure affecting SSSIs or protected species are likely to need consent. ■ **Note**: the surface of a public right of way (PROW) is generally not considered part of a protected site unless a specific feature, for example a stand of vegetation has been designated on or across it. ■ A PROW may require legal diversion if it becomes unusable, and may require a SSSI diversion order if a protected site is affected. ■ Planting and biodiversity gain will need to be considered in the context of wider land management and conservation targets and designations to increase effectiveness and identify any conflicts of interest.
More frequent flooding	■ Undertake more frequent maintenance and/or maintain to a higher specification, for example resurfacing paths and clearing debris from surfaces. ■ Increase maintenance or specification requirements for watercourses and flood-banks where routes and recreation areas cannot be relocated. ■ Working with natural processes, allow room for landscapes to change and evolve more naturally, and plan the repositioning of routes and other recreation facilities as the landscape develops. ■ When replacing footpath and bridle path bridges, adopt more resilient designs, for example with open lattice to allow freer water flow and/or higher and wider spans to withstand periodic high flows. ■ It may be possible to negotiate temporary, permissive alternative routes with landowners, or for new rights of ways to be dedicated permanently.	■ Increased surface maintenance and the need for resurfacing will place extra demands on budgets and on the available workforce. ■ Enhancing flood management infrastructure will place additional pressure on funding sources, and new resources may need to be secured. This may be difficult to justify when resources are limited, and when there may be clear conservation arguments for allowing rivers and their flood plains to operate more naturally in times of flood. ■ Diverting a PROW can be time consuming and expensive, and may not be possible, in which case the route may be lost permanently. ■ Adopting a 'roll-back' approach may be possible for the ECP, but is not usually an option for public rights of way.
Increased coastal flooding and erosion	■ Use the roll-back provision where possible (i.e. for the England Coast Path) and identify optional alternative routes where appropriate. ■ Managed realignment to restore or create intertidal habitat schemes at the coast should incorporate relocation of access routes and the creation of new access opportunities.	■ On rapidly eroding coasts, the implications for available funding and staff time could be significant

Climate change impact	Potential adaptation options	Possible issues
Increase in probability and severity of wildfire risk (see Peak District National Park case study)	■ CROW open access land restrictions can be used to reduce the risk of fire and potential danger to visitors. The relevant authority can make restrictions during exceptional conditions as identified via the Fire Severity Index (FSI). ■ The public can be encouraged to identify and report fire outbreaks via leaflets, posters and other informative material.	■ CROW restrictions do not affect public rights of way
Damage and disturbance to habitats/species caused by higher visitor numbers	■ Ensure that visitor management plans for sites and areas identify and address climate change impacts. ■ Develop, promote and maintain visitor routes and venues to reduce potential pressure on sensitive sites. ■ Use on site visitor management techniques to improve the visitor experience in non-sensitive areas. ■ Develop educational and interpretive resources to influence visitor behaviour and explain why management actions such as closing access to sensitive sites or asking people to use different routes is necessary. ■ Open Access land and the England Coast Path (ECP) have mechanisms for assessing access impacts on protected sites, e.g. the Access and Sensitive Features Assessment Process (ASFA) (Natural England 2017b) for the ECP. ■ SSSI diversion orders may be used where use of a right of way is causing damage to the special features of a SSSI.	■ The SSSI diversion order process requires that Traffic Regulation Orders are used in the first instance and that an acceptable alternative route has been identified.
Increased pressure on access infrastructure by higher visitor numbers.	■ It may be possible to reduce impacts by adopting more resilient designs/standards, and by managing visitors to spread pressures between different sites and path networks.	■ The ability to adapt may be limited by budgets and staff resources, or by a lack of alternative routes or sites.

Approaches to risk assessment and strategic planning for access and recreation

Identifying the risks from climate change and planning suitable adaptation responses is increasingly acknowledged as a requirement for all access and outdoor recreation resources. The general approach to identifying and responding to risks is similar to that for managing habitats and species covered elsewhere in this manual.

Ignoring the impacts of climate change is generally not a viable option since it could lead to a loss of public amenity, non-compliance with statutory duties, and potentially greater overall costs in the long term. Available resources will determine how much can be done, but it is important to systematically identify and consider potential impacts in order to plan for their current and future management.

Adaptation planning for recreation will generally follow a clear planning cycle. Scottish Natural Heritage (SNH) (Scottish Natural Heritage 2011) recommend six stages:

1. **Identify vulnerabilities**. Identify the acute and chronic impacts and pressures on access resources.

2. **Carry out a risk assessment**. What level of risk do the identified impacts represent, with risk being a function of the probability of the event occurring and the magnitude of its impact. High probability, high impact events will be at the high risk end of the scale and low impact, low probability events at the other.

3. **Generate risk management options**. The risk assessment process informs the selection of management options, i.e. reducing risk to a manageable level and/or taking opportunities to manage existing risk better.

   SNH identify four main generic options:

   - Business as usual - maintain and construct to existing best practice.
   - Future proof designs - construct to higher specifications or in different locations.
   - Retro-fit solutions - improve resilience by adapting existing infrastructure.
   - Develop contingency plans - e.g. re-construct key infrastructure, or downgrade or abandon paths or structures where it is no longer viable to maintain them.

4. **Carry out a cost benefit analysis**. Identifying the costs and benefits of different management options is important and can be valuable in making a case for funding. Budgets for access management can be limited, but opportunities can occur. For example, the Cumbria Countryside Access Fund (see case study), which was established following the 2015 floods, has focussed on the economic and social benefits that public use of the path network can bring.

5. **Implement chosen options.** Once a decision has been made and resources identified, a programme of action tailored to the site or area involved can be rolled-out.

6. **Monitor and review**. Monitoring and reviewing the effect of any actions taken will be vital for future adaptation planning. Being able to be respond to changing environmental conditions, as well as changes in visitor behaviour, will give any management programme essential flexibility.

The more detailed the assessment of climate change risks then the more data will be available for asset management (e.g. by carrying out or commissioning professional hydrological or geomorphological assessments). Rights of way and other access resource managers will often have direct, practical experience of dealing with the effects of changing weather conditions and will have experienced changes first hand, which should also be taken in to account in assessments.

Scottish Natural Heritage (2011) noted that adequate design, good practice and construction standards already exist for paths to cope with long-term physical conditions, and that future-proofing for climate change adaptation and resilience relies on 'planned, preventative maintenance'. The knowledge and best practice to work with and manage the effects of climate change on recreational networks is often already there, and many managers have the front-line experience and skills needed to pass these on to others.

Case studies

Building resilience following the Lake District floods of 2007, 2009 and 2015

Cumbria and English Lake District suffered devastating floods in late 2009 and again, as a result of Storm Desmond, in the winter of 2015. These events followed previous extreme flooding events in 2005 and 2007. The events severely affected communities; flooding people's homes, destroying infrastructure and inundating farmland. The visitor economy, the Lake District's main revenue source, was also severely affected.

A significant part of that economy is the outdoor sport, education and recreation sector, which in Cumbria for example employs over 5000 people in 400 businesses, and contributes around £250 million a year to the area's economy (Cumbria Vision 2009).

Storm damage on Cat Bells footpath. © Jessie Binns, National Trust

Both the 2009 and 2015 flood events had a major impact on the region's public rights of way network which, along with the extensive areas of access land, provides the main infrastructure for recreational activities. In both cases, the recovery programmes were prioritised using criteria relating to the protection and benefit of: local communities, the visitor economy, protected sites and climate change resilience.

The impacts of the events comprise acute impacts directly related to the events, i.e. destruction of infrastructure and inundation of networks, but will also have exacerbated longer term, chronic climate effects. Rainfall is one of the key factors in determining the scale of footpath erosion, which is primarily influenced by three factors: water (rainfall intensity), variation in path gradient (slope) and recreational pressure (trampling) (McEvoy *et al* 2008).

In 2009, there were 319 separate damage reports within the Lake District National Park (LDNP) public rights of way network, with an estimated £4 million of damage incurred (**Cumbria Floods 2009 GOV.UK Incident Report**) (Cumbria County Council 2010). This damage consisted mainly of destroyed, or badly eroded, paths and damaged access furniture, (e.g. lost footbridges, signs, gates and stiles). 253 bridges were lost, 85 public paths had surfaces severely damaged and 70 had destroyed access furniture (**LDNP ROWIP delivery report 2009/10**) (Lake District National Park). Grants of £250,000 towards repair of the damage were secured from Defra in 2009/10 and 2010/11 (**LDNP ROWIP delivery report 2009/10**) (Lake District National Park). Similar resources were made available following flood events in 2013/14 for the Broads, Exmoor, Dartmoor, North York Moors and Yorkshire Dales National Parks, each of which received a share of £400k for recreational infrastructure repairs (**.GOV press release 2014**) (UK Government 2014)

In 2015, within the LDNP, 562 kms of public rights of way were affected by the floods, generating a repair bill of £5.8 million and severely compromising access resources for visitors, communities and the local economy.

The Cumbria Countryside Access Fund was set up following the 2015 floods. £3 million was allocated to the LDNP, with a further £500k going to Cumbria County Council and the Canals and Rivers Trust. The LDNP will use the resources from the fund to help their resulting '**Routes to Resilience**' (Lake District National Park 2017) programme.

Damaged bridleway ford and footbridge at Townend © Natural England/A Mackintosh

The funds priorities are:

- rights of way that lead to or connect rural towns and villages, visitor attractions or assets
- multi-user and long distance trails
- rights of way that pass through environmentally sensitive areas such as Sites of Special Scientific Interest
- Proposals for funded works also had to demonstrate that climate change resilience was taken into account in any proposed works, for example by using improved surface materials for paths and using flood resilient designs for bridges. The project ended in February 2019 and had restored 94 bridges, 65 public paths and 44 items of access furniture.

Repaired section of Cat Bells path with improved drainage culvert. © Natural England/A Mackintosh

The England Coast Path near Minehead, Somerset. © Natural England/A Mackintosh

England Coast Path, building in flexibility

Coastal erosion to roads and footpaths in the East Riding of Yorkshire. © Natural England/A Mackintosh

Public Rights of Way are tied to a legally determined fixed route. If the physical route is lost through erosion, for example along a river bank or on an eroding stretch of coast, the legal rights of access associated with the route are also lost. Creating a permanent alternative route will usually involve a statutory diversion or creation order, which can take time and is not always possible to achieve.

The England Coast Path (ECP), which is being implemented by Natural England under provisions of the Marine and Coastal Access Act 2009, adopts a different, more flexible approach. Where NE proposed roll back as part of its alignment proposals and where these proposals have been approved by the Secretary of State, the ECP can be moved back in land on the coast without any further approval from the Secretary of State. Roll back can happen for example where significant coastal erosion or physical change occurs due to geomorphological processes such as landslips, or where there is significant encroachment by the sea as a result of a natural or deliberate breach of existing sea defences. Natural England's (2013) **Coastal Access Scheme** sets out the methodology for implementing the coast path route and the associated coastal margin.

Once a stretch of coastline has been assessed, a report is submitted to the Secretary of State recommending the alignment of the route, the extent of the coastal margin to be established either side of the route, and any specific management measures necessary for example: for the protection of vulnerable sites or species. If approved by the Secretary of State, the new access rights along the relevant stretch of coast are brought into effect by Order.

A list of grounds for providing a direction to restrict access are detailed in Chapter 6 of the Coastal Access Scheme and include: fire prevention, nature conservation, land management and public safety; all of which provide potential options for visitor management necessitated by climate change impacts.

The effect of roll-back, and options for alternative routing and restrictions, gives the ECP a degree of flexibility to respond to the impacts of climate change. This flexibility is particularly useful on rapidly eroding coasts, and over time the experience of implementing and managing roll-back should provide useful insights into how to manage public access on the coast in response to a changing climate.

Moorland wildfire risk management

Wildfire Baildon Moor West Yorkshire. © Natural England/Dave Key

As noted previously, hotter, drier summers are one predicted outcome of climate change bringing with it a higher risk of summer wildfires via high temperature, drier conditions and greater potential fuel sources. Furthermore, Albersten *et al* (2010), with reference to the Peak District moorlands, also note that the likelihood of spring wildfires is not necessarily reduced by wetter winters. They also note that, in addition to biophysical fire hazards, recreation provides a 'major ignition source' - via either intentional or accidental fire starting – and that hotter, drier conditions may lead to an increase in total visitor numbers and/or a concentration of visits on warmer drier periods thereby increasing that risk. However, this risk can potentially be mitigated by increased awareness of the risk and effects of wildfires as well as management measure such as creating firebreaks and/or removing potential fuel.

Wildfires result in vegetation damage and species loss and, with many upland habitats, including heath and blanket bog, being areas of high biodiversity value (and protected sites under UK and European legislation), these are clearly major conservation concerns.

Increased wildfire risk will also impact on the availability of public access; particularly for users of access land which can be closed in the event of high fire risk. Hotter, drier weather may also lead to an increased demand for shadier routes, e.g. in woodlands, or routes nearer lakes or reservoirs, and greater visitor numbers generally will put more pressure on available visitor resources and infrastructure.

Authorities and organisations who are responsible for and manage areas of high wildfire risk obviously need to take these risks into account when planning and implementing biodiversity and visitor management strategies.

Evidence and Strategic planning. The Peak District National Park state 'The Since 1976 there have been over 350 reported incidents of 'wildfires' of which the majority are commonly started by arson, discarded cigarettes, barbeques and campfires.' In response to this ongoing risk The Peak District Fire Operations Group (FOG) was formed to co-ordinate fire-fighting resources and currently includes serving fire officers and land and recreation managers,

Fire plans have been put in place for moorland areas in the Peak District and South Pennine Moors and wildfire risk maps produced to inform wildfire response planning. Data from fire records and ranger observations/logs have been used to map and produce models predicting where fires are most likely to occur. A vulnerability score was derived for identified habitat types, based on the number of actual past fires relative to the number expected in each area, and additional human and physical data layers applied to build the risk maps. It was also identified that ignition risk increases closer to access points (Walker *et al* Moors for the Future Partnership 2009 and McEvoy *et al* 2008).

Visitor engagement. Actions can include providing information to raise awareness about the risks of wildfire and engaging with the public and local communities to help with fire prevention and encourage better reporting of wildfires.

The main messages that local authorities and bodies such as Moors for the Future want to convey to the public are:

- The extreme vulnerability of the moorland in dry conditions.
- The most likely causes of fire, particularly smoking and the use of matches.
- The severe environmental damage to moorland caused by fire.
- Appealing for help in preventing and reporting fires

Access management. Access Authorities as defined by the Countryside and Rights of Way (CROW) Act 2000, are responsible for closing access land in response to fire risk. The decision to close moorland is determined by the 'Meteorological Office Fire Severity Index', which has 5 levels. The right of access under the CROW Act is suspended when the level reaches 5, but public rights of way, as highways, are unaffected by this legislation and remain open.

Another option in tackling wildfire management is the use of **Public Space Protection Orders** (PSPO's) under the Anti-social Behaviour, Crime and Policing Act 2014. In 2019 Bradford Council introduced a PSPO prohibiting the use of barbeques, fires, fireworks, Chinese lanterns etc. within defined areas covering the popular Ilkley, Baildon and 'Bronte' moors near Howarth in West Yorkshire.

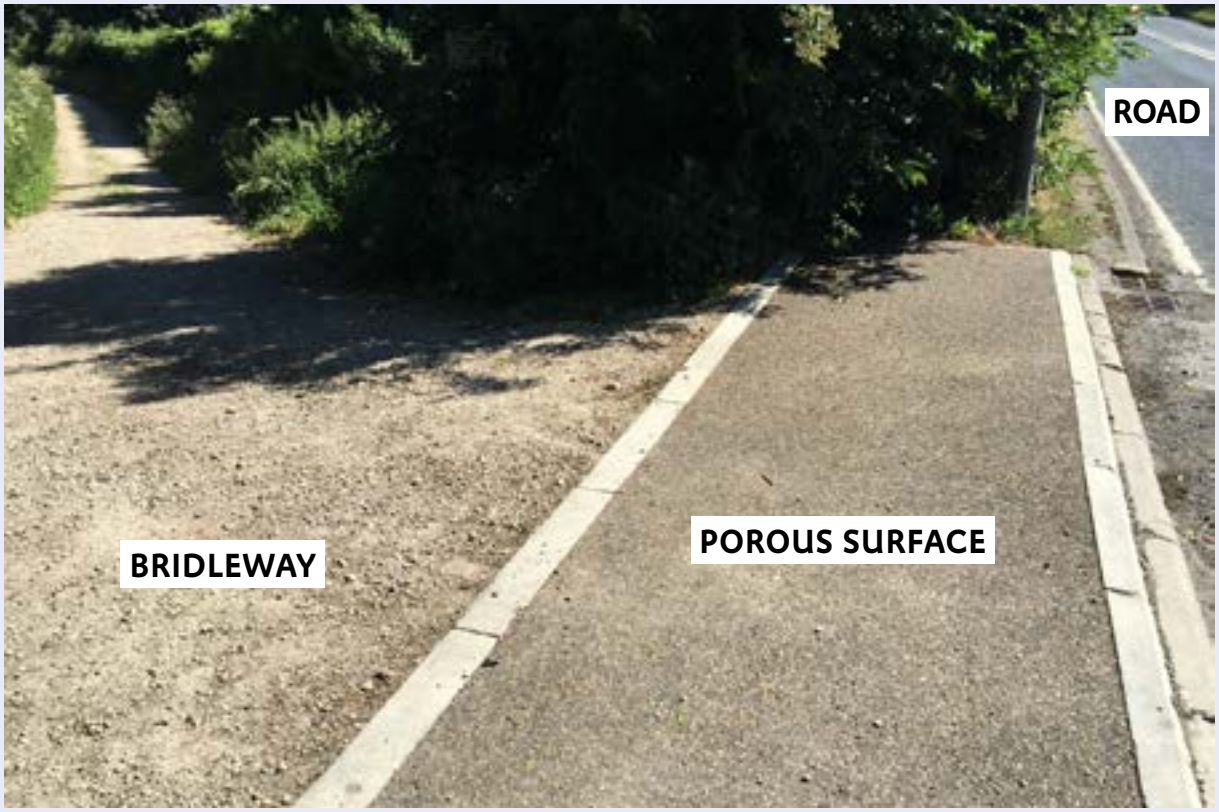
West Yorkshire/Leeds 2015 flooding

The 2015 Boxing Day flood had an unprecedented impact on West Yorkshire when up to 13 cm fell of rain fell on saturated ground causing multiple flooding events throughout the region, and particularly in the Upper Calder Valley and Leeds City Region. An estimated £500 million of damage ensued, affecting homes and businesses, and causing extensive infrastructure damage.

Access resources and networks were affected by erosion of path surfaces, loss of associated infrastructure and damage to drainage systems etc. Subsequent repair works, funded by partnerships between local authorities, SUSTRANS, Groundwork Leeds and the Canals and Rivers Trust, and from central government and the European Regional Development Fund, have ranged from relatively small scale adaptation works on individual paths, to large scale infrastructure replacement which, in some places, has provided an opportunity to incorporate public access improvements into flood defence and mitigation work.

East Keswick bridleway adaptation

Excessive runoff from the rainfall event was funnelled by asphalted roads towards a junction with the bridleway. The kerb was over-topped and the bridleway then provided a steep drainage route downslope towards the River Wharfe. The existing drainage ditch could not cope with the excessive water and the bridleway was badly eroded along its length with the resultant gullying making it unsafe and unusable for riding.



East Keswick Bridleway. © Natural England/A Mackintosh with thanks to R Brookes, Leeds City Council

The junction was identified as a vulnerable point for future flood risk events and the entrance to the right of way, which is also used by farm traffic, was adapted to be more resilient. The path was resurfaced and, at the junction, underground rainfall storage chambers were installed beneath porous surfacing with an overflow pipe directed into an improved drainage ditch.

Trans Pennine Trail, Leeds

The Trans-Pennine Trail (SUSTRANS Route 66) is a major coast-to-coast multi-user route, with a particularly popular section through Leeds used extensively for commuting and recreation.

The trail was damaged during the flooding and was affected by subsequent major infrastructure work connected with the Leeds Flood Alleviation Scheme (Leeds City Council 2016). Large scale infrastructure adaptation has included an innovative movable weir at Knostrop (below), flood walls, embankments, and the merging of the river and canal to increase water storage. The works entailed re-routing the trail, and the opportunity was taken to upgrade parts of the route and provide a new bridge over the weir.

Knostrop weir and Trans Pennine Trail bridge. © Natural England/A Mackintosh

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- **Lowland Paths Guide: A Good Practice Guide to Planning, Design, Construction and Maintenance of Lowland Paths in Scotland**.
- **Upland Path Management: Standards for delivering path projects in Scotland's mountains**.
- **Constructed tracks in the Scottish Uplands**.
- **Path Bridges: Planning, Design, Construction and Maintenance**.

SUSTRANS: **Traffic-free routes and greenways design guide**.