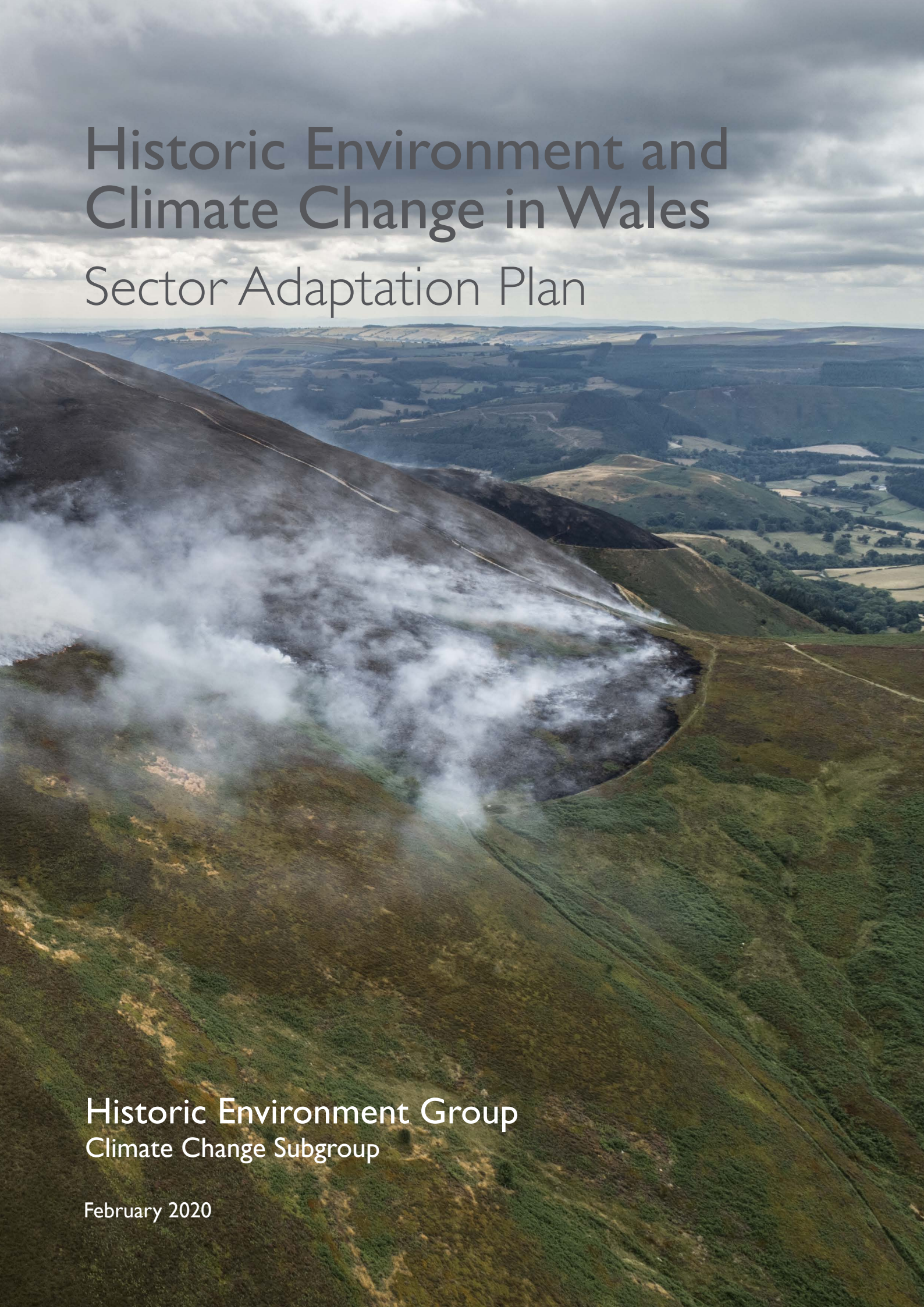
Historic Environment and Climate Change in Wales

Sector Adaptation Plan



Historic Environment Group
Climate Change Subgroup

February 2020

River flooding in the Vyrnwy Valley, Powys.

The Historic Environment Group (HEG) is a high-level forum set up by the Welsh Ministers in 2004 to take a strategic overview of issues and opportunities in the historic environment and to promote common approaches. The group is made up of representatives from the major organisations in Wales with historic environment interests.

The HEG Climate Change Subgroup is charged with assessing and reporting to HEG on how the historic environment sector in Wales should address the challenge of climate change.

Cyfoeth Naturiol Cymru Natural Resources Wales

Ymddiriedolaeth Genedlaethol National Trust

CBHC RCAHMW
Comisiwn Brenhinol Henebion Cymru
Royal Commission on the Ancient and Historical Monuments of Wales

Ymddiriedolaeth Archaeolegol Gwynedd
Gwynedd Archaeological Trust

Cadw

Llywodraeth Cymru
Welsh Government

Mae'r ddogfen yma hefyd ar gael yn Gymraeg. This document is also available in Welsh.

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Cover photograph: Wildfire in August 2018 on Llantysilio Mountain, part of the Clwydian Range and Dee Valley Area of Outstanding Natural Beauty.
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Contents ¬

Caerfai Camp, Pembrokeshire. Aerial image taken as part of erosion monitoring of the promontory fort.

Foreword ¬

Wales as a nation has emerged from a shared cultural inheritance over thousands of years. The historic environment is the physical manifestation of this cultural heritage. It is a precious resource that we must care for and pass on to our children to love, cherish and enjoy.

The layers of this history can be read in our landscapes and townscapes, and in the countless historic buildings and ancient monuments that are all around us. The chapel, the working man's institute, our homes and the local park, together with the patchwork of farmsteads, field boundaries and ancient woodland that make up our historic landscapes all form part of the unique sense of place that exists in each part of our nation.

We may not notice it as we go about our daily lives, but the historic environment is constantly changing and evolving through natural processes and human interventions. This inevitable change requires careful management to protect and enhance the special qualities that we value. Finding the right balance can be a challenge. However, we are now facing the greatest challenge of all from climate change. And we need to respond now to the consequences that we know are coming for the people of Wales, our communities and places.

The Welsh Government declared a climate emergency in April 2019 and we are committed to taking steps to limit climate change by reducing greenhouse gas emissions. Nevertheless, the impacts of climate change on the historic environment are already being felt. Taking action to prepare and adapt to the consequences will not be easy.

To increase the resilience of the historic environment we must first understand the risks and build capacity in the Welsh Government, public bodies, business and third sector organisations, as well as communities across Wales. This will require good governance, strong leadership and the allocation of resources.

I would like to thank the Historic Environment Group for leading the way by developing the Historic Environment and Climate Change in Wales Sector Adaptation Plan. It is a high-level, strategic document intended to identify climate change risks, opportunities and adaptation needs for the historic environment. Above all, it is a rallying cry to us all to rise to the challenge and start taking action now.

Lord Elis-Thomas AM
Deputy Minister for Culture, Sport and Tourism

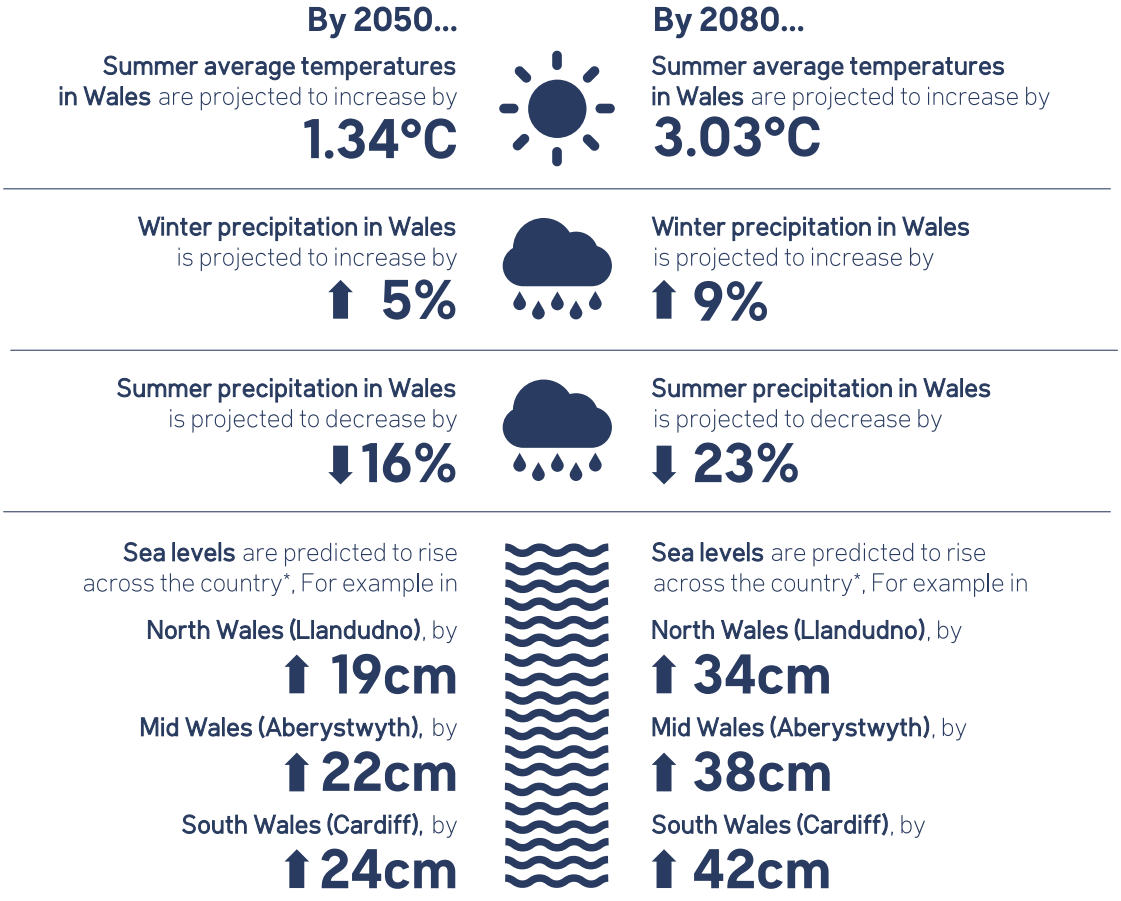
1. Introduction ¬

We are already experiencing the effects of Wales's changing climate. Warmer temperatures, rising sea levels, changing rainfall patterns and more frequent extreme weather events are now familiar. The impact of these effects on our historic assets, which are irreplaceable, will have significant consequences for the historic environment as a whole as well as the people of Wales. We have already seen the major impacts of flooding and coastal erosion on some of Wales's historic settlements, their residents and local economies. There are also likely to be longer-term and less direct impacts that we cannot yet predict or understand fully. We need to respond to these challenges and opportunities by considering what we can do now and in the future to help increase the resilience of the historic environment and take advantage of any opportunities that change may bring.

The Historic Environment Group (HEG) has prepared this plan to help raise awareness of the risks and opportunities of climate change for the historic environment of Wales and the need for adaptation. Our objective is to encourage collaboration and action across all sectors that will:

- **increase our knowledge** and understanding of the threats and opportunities for the historic environment from changing weather and climate in the short, medium and long term
- **increase our capacity** by developing the awareness, skills and tools to manage the impacts of climate change on the historic environment
- **build the resilience** of the historic environment by taking action to adapt and respond to the risks, reduce vulnerability and maximise the benefits.

Figure 1: Climate change predictions by 2050 and 2080 taken from the UK Climate Projections (UKCP18) dataset.[1]



1 UK Climate Projections (UKCP18), Met Office www.ukclimateprojections.metoffice.gov.uk/

A wide range of stakeholders from different sectors attended the 2018 stakeholder event in Aberystwyth.

This plan takes the UK Climate Projections (UKCP18)[2] and the *UK Climate Change Risk Assessment 2017 Evidence Report: Summary for Wales*[3] as the starting points for assessing future climate change and identifying potential adaptation measures. It is aimed at policy and plan makers, including the Welsh Government, local authorities and other public and third sector organisations, as well as non-governmental organisations, including academic institutions. All of these organisations have a vital role to play in developing and implementing the actions identified in this plan.

The plan describes the challenges posed by a changing climate on the historic environment. It identifies how we can improve our understanding of the processes involved and how they impact on the physical and cultural aspects of Wales's historic environment. It also discusses ways to build adaptive capacity and increase resilience by delivering adaptation actions.

Section 6 includes a detailed table of adaptation actions that build on the high-level strategic actions identified in the Welsh Government's 2019 adaptation plan *Prosperity for all: A climate conscious Wales*.[4] These actions are linked to predicted changes and potential risks to the historic environment. They aim to balance the sustainable management of the historic environment with the need to adapt to a changing climate, based on our current understanding.

The plan concludes with a summary of steps that the Historic Environment Group will take over the next five years.

Developing and publishing this plan has been a long process with stakeholder engagement at its heart. Well-attended workshops were run in 2015 and 2018. The positive and constructive cross-sector feedback from these events and the public consultation on the draft plan during 2018–19 have helped to inform the final version of this plan.

Many of the issues outlined here are not unique to the historic environment, which makes this plan relevant to other sectors too. We hope it will encourage organisations to work together to fulfil the national strategic priorities and actions. We will report progress to the Welsh Ministers on a regular basis.

2 UK Climate Projections (UKCP18), Met Office www.ukclimateprojections.metoffice.gov.uk/

3 *UK Climate Change Risk Assessment 2017 Evidence Report: Summary for Wales*, Committee on Climate Change www.theccc.org.uk/tackling-climate-change/preparing-for-climate-change/uk-climate-change-risk-assessment-2017/national-summaries/wales/

4 *Prosperity for all: A climate conscious Wales*, Welsh Government, 2019 www.gov.wales/prosperity-all-climate-conscious-wales

2. Understanding the historic environment and assessing risk ¬

Twm Barlwm is a large medieval motte inside an earlier defended enclosure. As an important local landmark on a high ridge it is heavily used and valued by local communities.

Extensive wild fires in 2018 burnt over half the monument and a sizeable area of forestry and moorland, exposing new archaeological features. Mapping and archaeological excavations will inform short-term emergency measures and a conservation plan.

The importance of the historic environment to Wales ¬

The historic environment comprises everything that results from the interaction of people and places through time. It includes all surviving physical remains of past human activity, whether visible, buried or submerged, deliberately planted or managed. It is a precious, irreplaceable resource and it needs to be managed and sustained for the benefit of present and future generations. As Wales looks forward to a sustainable future, the historic environment provides a tangible record of our shared past from which we can learn valuable lessons.

It contributes significantly to the Welsh economy, for example, through tourism, heritage regeneration, employment and skills development. *Heritage Counts Wales 2018–19*[5] estimated that the historic environment supports over 40,500 jobs, nearly 3 per cent of Wales's total employment.

The historic environment also provides many social, well-being and environmental benefits, including a sense of identity and a stimulus for community involvement, learning, leisure and recreation activities.

5 *Heritage Counts Wales 2018–19*, Historic Environment Group, 2020 www.cadw.gov.wales/

Understanding and assessing risk ¬

Climate change brings a number of significant challenges for the historic environment. The *UK Climate Risk Assessment 2017 Evidence Report: Summary for Wales*[6] predicts a rise in mean summer temperatures, changing winter precipitation and sea level rise.

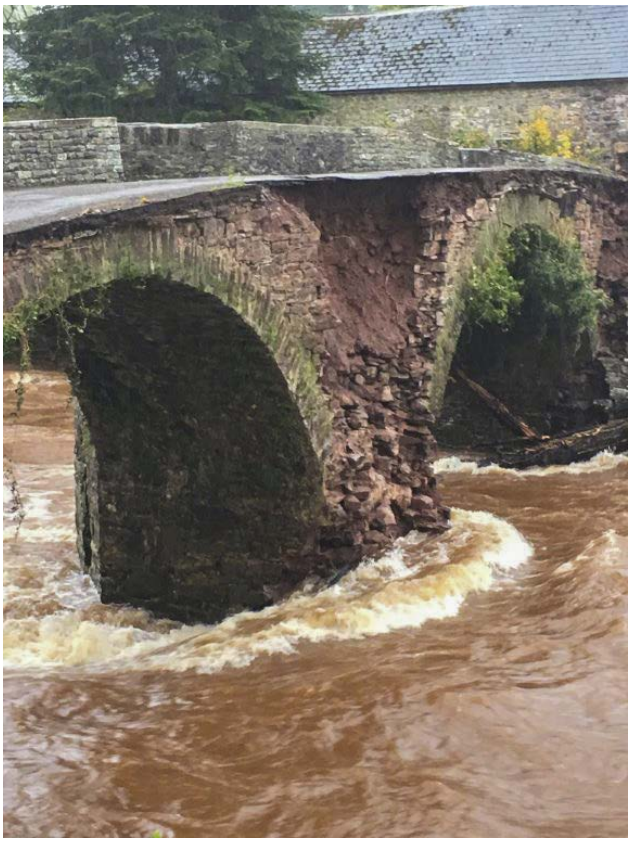
Depending on the type of historic asset, its use (if any) and location, the challenges that these changes present may be physical, economic and/or cultural. For example, all classes of historic asset are at risk from frequent high winds and storm events, including the associated storm surges, damage and erosion. Hotter, drier summers may increase tourism potential and support economic development, but increased visitor numbers can also risk harm to fragile historic assets.

It is also important to recognise that individual risks associated with climate change rarely act in isolation; more often, they interact and amplify other climate and non-climate related risks. For example, buildings and structures that are already poorly maintained are at much greater risk of storm damage. Similarly, veteran trees and historic woodland already stressed by drought are less able to withstand the onslaught of pests, diseases and storms.

The Historic Environment Group's report, A *strategic approach for assessing and addressing the potential impact of climate change on the historic environment of Wales*,[7] contains a useful methodology for assessing risk, which we have adapted for this sector adaptation plan. This methodology considers the likely extent and severity of impact on the historic environment against the sensitivity of historic assets to change. The assessed risks are then ascribed a level of significance: high, moderate or small negative, or positive.

This adaptation plan builds upon the results of the earlier report to produce an updated risk assessment for nine broad classes of historic asset (Table 1), based on form, function or location. It considers four descriptions of climate change and their predicted outcomes, and assesses the significance of the impacts of these changes based on extent, severity and sensitivity. We have included codes which identify the likely impacts and their significance for each category of historic asset. These codes are explained in Table 2.

Blank entries in Table 1 should not necessarily be construed as meaning that there is no impact. Instead, the table focuses on the most likely impacts based on current understanding, evidence and experience.



There are more than 1,000 listed bridges in Wales, which need regular upkeep from ever-shrinking budgets. Limited or poor maintenance puts them at greater risk from flood damage and scour. These bridges are essential for local communities and their closure can have devastating effects on local residents and businesses.

6 *UK Climate Change Risk Assessment 2017 Evidence Report: Summary for Wales*, Committee on Climate Change www.theccc.org.uk/tackling-climate-change/preparing-for-climate-change/uk-climate-change-risk-assessment-2017/national-summaries/wales/

7 Powell, J., Murphy, K., Ings, M., and Chambers, F.M, A *strategic approach for assessing and addressing the potential impact of climate change on the historic environment of Wales*, HEG, 2012

Table 1: An assessment of the likely impacts of climate change on historic assets in Wales and their significance. The impact summary codes are explained in Table 2.

Description of climate change	Warmer mean temperatures				Hotter, drier summers		Warmer, wetter winters	More frequent extreme weather
Predicted outcome of climate change on environment	Rise in sea levels	Migration and proliferation of pests, diseases and invasive species	Longer growing season	Changes in lifestyle and leisure patterns	Drying out, desiccation, shrinkage and erosion	Wild fires	More flooding events, increased ground moisture and precipitation	Frequent high winds, storms and heat/cold events
Buildings and settlements	SL1 SL2	PD1	LGS1	LEI1 LEI2	DRY1 DRY4	WF1	FL1	EX1 EX2
Marginal and upland		PD2	LGS1	LEI1 LEI2	DRY2 DRY3 DRY4	WF2	FL2 FL3	EX1 EX2
Marine and coastal	SL1 SL2	PD2	LGS1	LEI1 LEI2	DRY2		FL1	EX1 EX3
Rivers, canals, fresh water	SL1	PD2	LGS1	LEI1 LEI2	DRY1 DRY2 DRY3		FL1	EX1 EX2
Farmland		PD2	LGS1		DRY2 DRY3 DRY4		FL2 FL3	EX1 EX2
Woodland		PD2 PD3			DRY2 DRY3	WF2		EX1
Industrial landscapes	SL1	PD2	LGS1	LEI1 LEI2	DRY1 DRY2 DRY3 DRY4		FL2 FL3	EX1
Designed landscapes, parks and gardens		PD2 PD3	LGS2	LEI1 LEI2	DRY3 DRY4	WF1 WF2	FL1 FL2 FL3	EX1 EX2
Historic landscapes	SL1 SL2	PD2 PD3	LGS1	LEI1	DRY3 DRY4	WF1 WF2	FL1 FL3	EX1 EX2

Significance of impact:

High negative

Moderate negative

Small negative

Positive

Blank = limited/no impact

Table 2: The impact summary codes

Warmer mean temperatures	
Rise in sea levels (SL)	
SL1	**Persistent inundation and flooding** • Loss of historic settlements and structures. • Impact on heritage related coastal economy, e.g. heritage tourism. • Impact through loss and inundation of coastal archaeology on foreshore and coast edge e.g. ship wrecks, peat deposits and promontory forts. • Impact on coastal industries and installations e.g. tidal mills, fish weirs, salt works, limekilns.
SL2	**Impact from management response** • Direct and indirect impacts on historic assets and areas, and their settings from increasing or strengthened engineered/physical protections. • Response to managed retreat. • Potential adverse impacts from clean-up operations.
Migration and proliferation of pests, diseases and invasive species (PD)	
PD1	• Increased incidence and severity of fungal and insect attack and the impacts on the health of building fabric, occupants and collections/archives.
PD2	• Proliferation and expansion in range of invasive and non-native (INNS) species. • Change in marine species in response to warmer seas and increased acidification.
PD3	• Loss of species already at threshold of tolerance leading to changes in distinctive character. • Wide range of species susceptible to Phytopthora root rot in some gardens.
Longer growing season (LGS)	
LGS1	• Increased/spreading vegetation cover, obscuring historic assets/accelerating decay of building materials. • Expanding improved pasture and cultivation into uplands, including ploughing fields not recently cultivated. • Introduction of new crops/bio-energy crops and increasing cereals, intensifying farming practices and cultivation techniques that could impact adversely on buried archaeology. • Increased/longer period of maintenance tasks on historic assets. • Introduction of new species altering distinctive historic character.
LGS2	• Earlier flowering and later leaf fall potentially increasing visitors.
Changes in lifestyle and leisure patterns (LEI)	
LEI1	• Increased migration from urban centres to historic coastal resorts in response to overheating. • Increasing development/infrastructure pressure on coastal resorts for leisure to satisfy increasing visitor pressure. • Increased visitor pressure on historic coastal, upland, industrial, river and designed landscapes, parks and gardens.
LEI2	• Potential opportunities from increasing visitors and heritage tourism, including conservation-led regeneration.

Hotter, drier summers	
Drying out, desiccation, shrinkage and erosion (DRY)	
DRY1	Subsidence • Subsidence caused by clay shrinkage to features and structures e.g. buildings, breaches in flood defences, dams and reservoirs, shafts and underground workings, blockages of river courses.
DRY2	Erosion and destabilisation • Erosion of historic assets exposed by the lowering of lake, inland waterways and river levels. • Destabilisation/erosion of earth structures, embankments and cuttings. • Destabilisation of tips and industrial remains leading to landslides and increased potential for pollution. • Increased erosion from impaired pasture growth caused by desiccation. • Increased use of marginal pastures leading to erosion of archaeological remains. • Wind-blown movement of marine sediments, e.g. dunes, exposing historic assets. • Wind-blown contamination/pollution from metal mine sites e.g. tips, settling ponds.
DRY3	Drying out • Lowering of water table causing loss of paleoenvironmental evidence. • Drying out of blanket bog leading to dome collapse or erosion of exposed faces e.g. impact on peat as a paleoenvironmental record. • Changing decay and survival of organic artefacts e.g. trackways, peat processing sites, timber launder systems. • Operating historic water mills at risk from water shortage. • Increased risks to historic assets from irrigation systems on farmland. • Changing use of agricultural land and buildings to cope with water shortages, lack of fodder and poor harvests. • Drying and stress to veteran trees, historic woodland and their contribution to setting.
DRY4	• Exposure of industrial remains buried beneath redeposited peaty sediments e.g. potential prehistoric mining remains, smelting sites. • Discovery of new historic assets in desiccated grassland and crops visible as parch and crop marks. • Improved humidity levels in buildings.
Wild fires (WF)	
WF1	Built • Increased risk of fire in buildings and structures from drier conditions. • Wild fires causing damage to buried and above ground archaeology, buildings and structures.
WF2	Vegetation • Changes in species leading to alterations to the ecology, vegetation and historic landscape character. • Increased risk of erosion and subsequent loss of peat as a paleoenvironmental record resulting from fire damage to surface vegetation and its protective effect.

Warmer, wetter winters	
More flooding events; increased ground moisture and precipitation (FL)	
FL1	**Increased erosion, scour and other damage** • Damage to historic buildings, settlements, infrastructure and designed features. • Destabilisation and subsidence of archaeology on the coast edge. • Erosion, damage or loss of buried and above ground archaeological remains. • Increased pressure, scour and damage to water-related features e.g. bridges, overtopping of dams. • Potential adverse impact from clean-up operations and modifications e.g. installation of property flood resilience measures.
FL2	**Physical and chemical changes** • Increased risk of physical (mechanical) damage through the use of agricultural machinery on waterlogged soils, including 'poaching' by livestock near historic assets. • Persistent saturation resulting in chemical changes to buried archaeology.
FL3	**Destabilisation and pollution** • Inadvertent pollution episodes from flooding and increased precipitation e.g. metal mines. • Destabilisation and subsidence of archaeology on spoil and waste tips, designed features, archaeological deposits and earth structures leading to slippage or collapse. • Potential adverse impact from clean-up operations.
More frequent extreme weather	
Frequent high winds, storms and heat/cold events (EX)	
EX1	**Damage from increased precipitation/high wind events** • Storm damage to features, historic buildings, settlements and structures above ground. • Wind driven rain and increased humidity with resulting impact on indoor air quality and health of building fabric, occupants and collections/archives. • Increased high-energy flooding events (see FL1, FL2). • Turbulent seas leading to damage/scour to underwater, intertidal and coast-edge archaeology. • Increased sediment transport leading to exposure of historic assets. • Direct impact from storms causing damage to veteran trees and woodland. • Cumulative impacts from multiple events. • Potential adverse impact from clean-up operations and modifications. • Increased maintenance and repair costs.
EX2	**Extreme heat/drought and cold events** • Potential direct and indirect impacts from extremes and fluctuations affecting physical weathering, exacerbating building material and structural problems e.g. freeze/thaw action, shrinkage. • Overheating of buildings and potential for maladaptation e.g. poorly designed air conditioning. • Changing land use to cope with the impacts of extreme and fluctuating weather conditions. • Increased heat and drought impacting on veteran trees and woodland.
EX3	• Discovery of new historic assets following exposure by coastal erosion or movement of sediment.

The impacts of climate change can be far reaching. As well as being a drain on local authority resources, cleaning up the aftermath of recurring storms, such as this one in Aberystwyth, can affect heritage tourism and the businesses and communities that it supports.

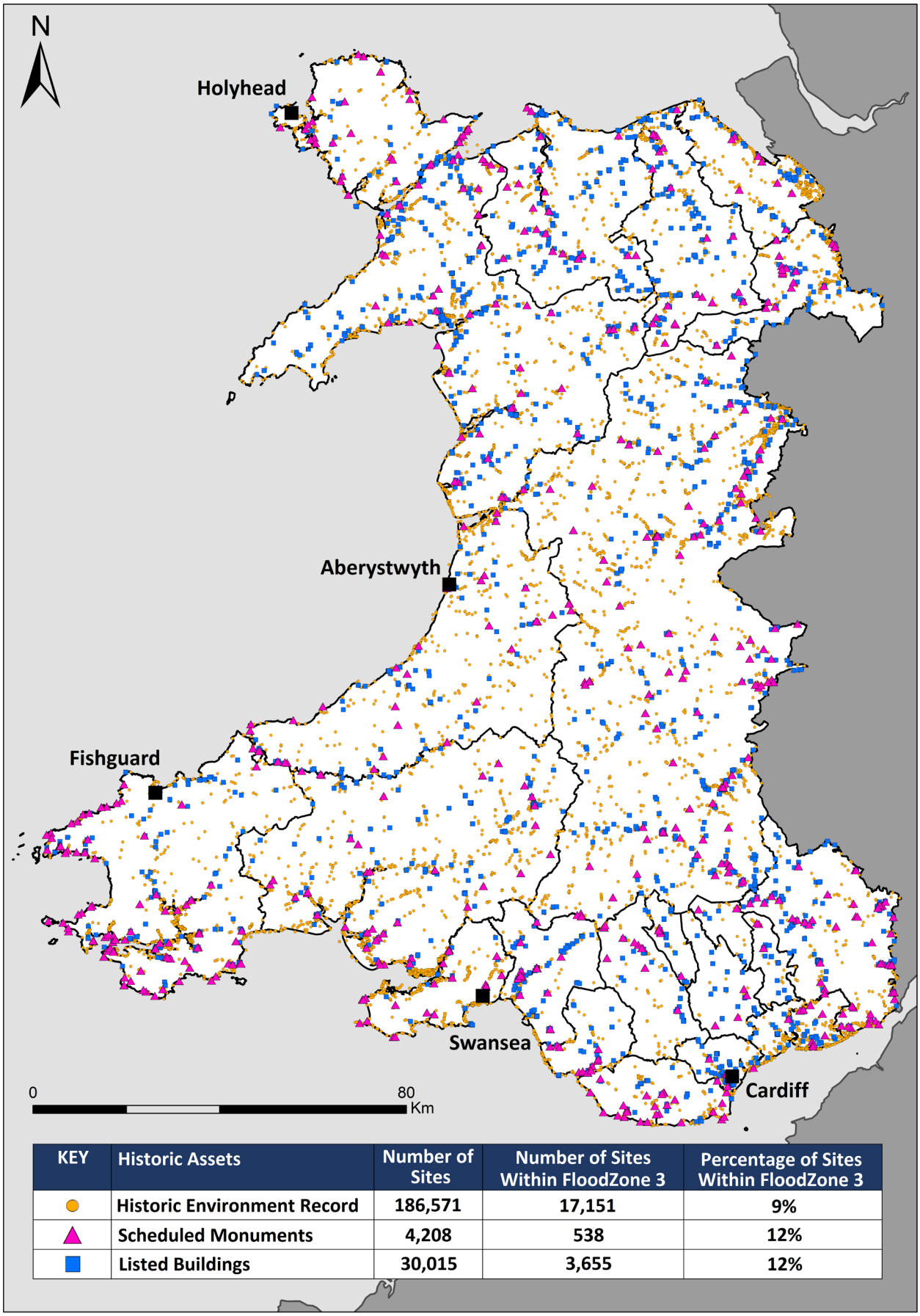
The challenge for Wales's historic environment from climate change can be summarised as follows.

- Historic assets associated with coastal, freshwater, woodland and built environments are at high risk, mostly from more frequent extreme weather, increased flood events, rising sea levels, changes to peaty soils, pests and diseases.
- A large number of assets are potentially at moderate risk from a wide range of climate change events. Cumulatively, we should consider these risks to be of high significance. Historic landscapes associated with the nine categories considered in the table are particularly vulnerable as the cumulative loss of historic assets may affect the integrity and survival of the historic landscape as a whole. For example, the loss of hedgerows and boundaries leads to loss of fieldscape which may alter the spatial arrangement, pattern and understanding of vernacular buildings.
- If managed well, there may be small positive outcomes arising from a longer growing season, drying out of buildings and the associated reduced humidity, and changing leisure patterns. The discovery of new historic assets in desiccated grassland and crops visible, as parch and crop marks, may also be a beneficial outcome from drying out. Coastal erosion and the movement of marine sediments may reveal previously unknown sites. The conversion of formal lawns to meadow in response to the longer growing season in designed landscapes may increase species count in the natural environment and have the benefit of reducing mowing and maintenance costs, but may have a significant impact on the character of historic parks and gardens.

By identifying and understanding the threats, we can make a more informed and planned response to the impacts of climate change. One way of doing this is through the collation of an evidence base against which the risk and resilience of historic assets can be modelled using spatial mapping.

In Wales, a spatial mapping project has identified the number of historic assets that could be at risk from climate change, an example of which is shown in Figure 2. Led by the Royal Commission on the Ancient and Historical Monuments of Wales (RCAHMW), the methodology for the project draws upon a number of dynamic spatial data sets, including LiDAR, flood risk data and intertidal data. Further work to develop clearer identification and understanding of the threats, alongside an improved evidence base, will allow us to adapt and prioritise our efforts.

Figure 2: Identification of historic assets in Flood Zone 3. These have a 100 to 1 chance of future flooding from rivers or a 200 to 1 chance of flooding from the sea.



KEY	Historic Assets	Number of Sites	Number of Sites Within FloodZone 3	Percentage of Sites Within FloodZone 3
●	Historic Environment Record	186,571	17,151	9%
▲	Scheduled Monuments	4,208	538	12%
■	Listed Buildings	30,015	3,655	12%

3. Resilience in the historic environment ¬

What is climate change adaptation? ¬

The terms mitigation and adaptation are often confused though both responses to climate change are needed urgently. Mitigation means taking actions to limit the rate of long-term climate change and its related effects. This generally involves reducing greenhouse gas emissions through energy efficiency measures for example. Mitigation may also be achieved by increasing the capacity of carbon sinks through reforestation and similar measures. In short, mitigation is about tackling the root causes of climate change.

In contrast, adaptation is the process of adjustment to actual or expected climate change and its effects. If carefully designed, some actions can achieve both adaptation and mitigation. Peatland restoration, for example, can improve carbon sequestration, as well as protecting buried archaeology against the harmful effects of exposure, drying out and wild fires.

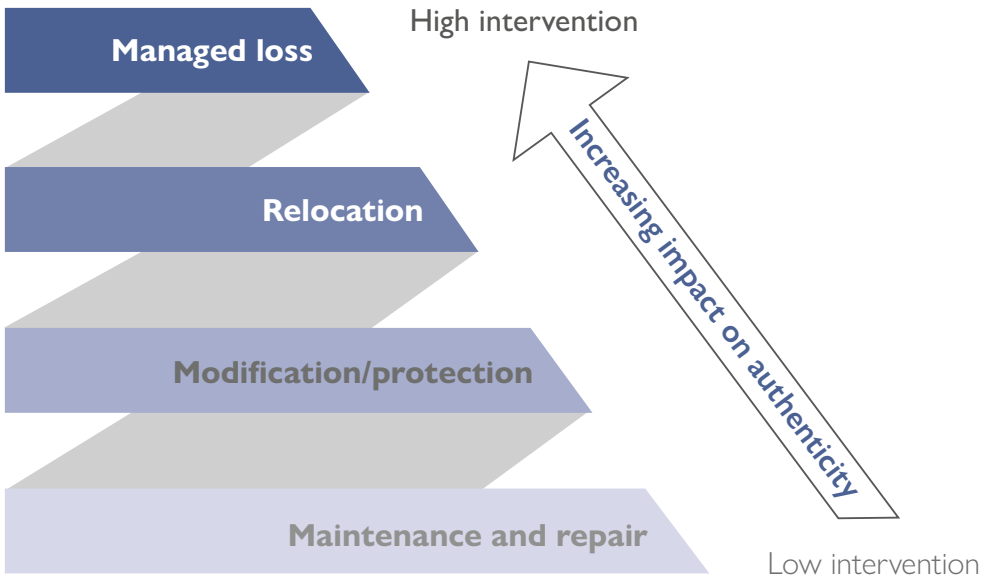
Whilst good practice dictates that every intervention should try to maximise added benefits and synergies, this plan does not directly address the wider climate change agenda or mitigation. Instead, we are focussing on adaptation, which has so far received little attention in terms of policy development.

Adaptation in the historic environment means a process of ongoing management. Keeping historic assets in a good state of repair through proactive maintenance and sensitive modification, such as improving drainage around historic buildings and structures, is a simple and cost-effective way of increasing their resilience. Where a greater level of intervention is required, our priorities and the solutions available will vary depending on the situation, timeframe and type of historic asset.

Adaptation may be reactive. For example, we are already seeing the loss of archaeological sites and other historic assets as a result of coastal erosion. We know that these losses will continue and that other changes beyond our control will take place. To date, our response has been largely reactive and limited to recording and investigation as loss is happening. However, we may be able to achieve better outcomes by planning and anticipating adaptation. This may involve simple changes in management practices or the provision of physical barriers to protect historic assets. It could also include more active interventions, such as moving assets to a safer site if appropriate, or pre-emptive preservation by record where loss is inevitable or desirable for other, more pressing reasons.

Figure 3 illustrates the levels of adaptive intervention and their impact on the authenticity of historic assets. Maintenance and repair is the most common and lowest level of intervention. It also has the least impact on authenticity.

Figure 3: Different levels of adaptive intervention and their impact on the authenticity of historic assets.



Individuals and organisations will be able to take some action themselves; this may already be happening, though it may not be recognised as adaptation. An example would be assessing the vulnerability of a historic building or site and preparing an emergency plan to help minimise the impacts of extreme weather events.

Other actions will require a coordinated response to develop and implement targeted adaptation programmes and strategies. Partnership working is often crucial, where problems originate beyond the boundary of a site for instance. It is therefore essential that we work together to share good practice and ensure that the historic environment is considered in all areas of policy development, plan-making and implementation. This inclusive approach is supported by the Well-being of Future Generations (Wales) Act 2015,[8] which requires the public bodies listed to work towards achieving all of the seven well-being goals shown in Figure 4.

Principles of sustainable adaptation and ways of working ¬

The sustainable development principle and the five ways of working embodied in the Well-being of Future Generations (Wales) Act 2015[9] provide a useful framework to aid public bodies in their decision-making. We have used these to create a set of principles to help guide the development of sustainable adaptation.

Figure 4: The seven well-being goals from the Well-being of Future Generations (Wales) Act 2015.[10]

8 Well-being of Future Generations (Wales) Act 2015 www.legislation.gov.uk/anaw/2015/2/contents/enacted www.gov.wales/topics/people-and-communities/people/future-generations-act/?lang=en

9 Well-being of Future Generations (Wales) Act 2015 www.legislation.gov.uk/anaw/2015/2/contents/enacted www.gov.wales/topics/people-and-communities/people/future-generations-act/?lang=en

10 Well-being of Future Generations (Wales) Act 2015 www.legislation.gov.uk/anaw/2015/2/contents/enacted www.gov.wales/topics/people-and-communities/people/future-generations-act/?lang=en

Adopting these principles will help us to implement the right adaptation action in the right place, using resources efficiently and proportionately. Actions will reflect the level of risk and the desired outcomes, and be implemented at the most appropriate time and level, be that national, regional or local. Our estimation of costs and losses will also take account of economic, social, environmental and cultural considerations.

The principles of sustainable adaptation ¬

Long term

We should consider the long-term impact of adaptation actions. Wherever possible, actions should not add to climate change, increase the vulnerability of another location, sector or part of society, or limit the ability of future generations to adapt.

Prevention

Adaptation actions should be anticipated and implemented where possible to prevent adverse outcomes. Actions must take account of the uncertainties of climate projections. They should be informed by a cycle of monitoring and evaluation, and adjusted as new understanding and information become available.

To avoid maladaptation, we should consider the full range of interactions and any short- and long-term unintended consequences that may arise.

Integration

Climate change assessment and adaptation should be embedded in normal business planning and risk management activities. Actions should seek to improve the wider economic, social, environmental and cultural well-being of Wales.

Collaboration

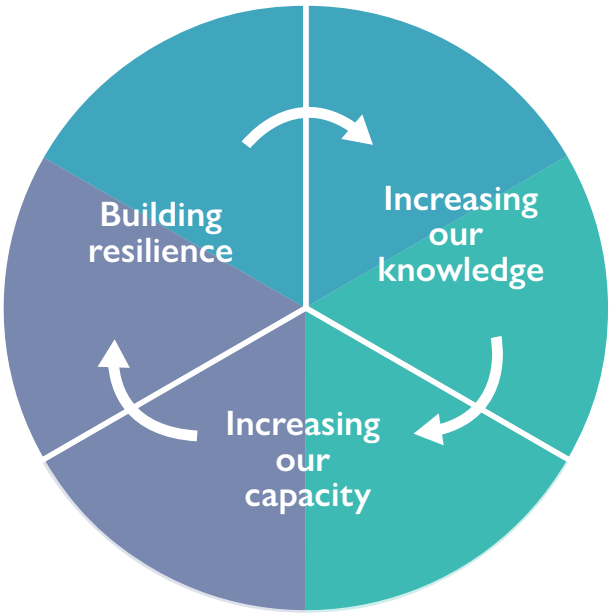
We need to develop new and existing partnerships and networks to work together to understand climate change impacts, agree priorities and implement actions. A joined-up, strategic approach will help to resolve potentially conflicting aims and build cooperation and ownership of the adaptation process.

We need to work across sectors to share good practice and ensure that the historic environment is considered in all areas of policy development, plan-making and implementation. This will help to maximise the cross benefits and synergies.

Involvement

Adapting to climate change is a long-term issue that will require ongoing commitment from organisations, businesses and communities across Wales. To be effective and have the greatest reach, we need to engage widely and involve a diverse range of people and organisations in the development and implementation of adaptation actions.

Figure 5: Increasing our knowledge helps us to increase our capacity and build our resilience. This will help us to identify further gaps in our knowledge that we need to fill.



Types of adaptive action ¬

The actions in Section 6 of this plan fall broadly into three overlapping and connected areas of work to increase our knowledge, increase our capacity and improve our resilience. Figure 5 shows how these areas relate to each other.

Increasing our knowledge ¬

We have been adapting to climate change from the earliest of times on an ad hoc basis. New science and technologies enable us to look at climate change adaptation coherently on a national scale as well as at the local level. To ensure that guidance and actions are evidence based and targeted, we need a range of research projects and case studies to improve understanding of many of the anticipated impacts on the historic environment, and to develop good practice. Enhanced information and understanding can underpin adaptation actions for assets vulnerable to changes, including sea level rise, drying of clay soils, storm surges and extreme weather.

We also need further research to understand the impacts of change over time. For example, although sea level rise has the potential to cause negative impacts on the historic environment, it also has the potential to preserve historic assets once they are submerged. Similarly, burial by wind-blown sediments, such as sand, may preserve assets for future generations.

Increasing our capacity ¬

The second area of work relates to identifying capacity needs and shortfalls. It involves encouraging the development of informed guidance and training to build the adaptive capacity of organisations and individuals. Guidance exists on topics such as coastal change and the natural environment, but this does not always take into account the historic environment. Integrated, cross-sector working on such guidance presents an opportunity for the historic environment sector. Shoreline management plans[11] are a good example of integrated thinking, but awareness of the historic environment needs to be raised more widely if inclusive planning is to become the norm.

Preparing for storm events and clearing up in their aftermath, managing changing land use and changing patterns of tourism and recreation are examples of areas where the need for guidance and best practice has been identified. Other activities will include setting up cross-sector working groups to share knowledge and develop case studies, and embedding adaptation into management strategies and business plans.

11 www.gov.uk/government/publications/shoreline-management-plans-smps

Dinas Dinlle coastal hillfort which is being eroded by the sea.

Excavation of the eroding cliff face of the hillfort in June 2019 by the CHERISH Project.

Building our resilience ¬

Resilience has been defined as 'the capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganising in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, learning and transformation.'[12]

This third area of work is the direct action necessary to increase the resilience of historic assets to absorb new and increasing stresses, and to improve systems to cope with changing circumstances. The overall aim is to enable systems to adapt to negative change in a sustainable manner.

The resilience of the historic environment will depend on the nature of the threat and the historic asset, as well as socio-economic factors to facilitate adaptation responses. Examples of activities to increase resilience include changing land management techniques to improve water infiltration and reduce surface water run-off, and implementing community programmes and engagement to monitor and record structures at risk.

Notwithstanding our best efforts to protect the historic environment, we will also need to learn how to manage the loss of historic assets. Loss will be an inevitable outcome of climate change in some situations. We are already seeing the dramatic effects of coastal erosion and coastal realignment. This is only likely to become more commonplace as the impact of climate change increases and we move away from building hard defences towards more nature-based solutions.

Loss may also be more insidious and incremental, such as the accelerated erosion of architectural features as a result of increased rainfall, wind and vegetation growth, or the cumulative impacts of drought, pests and diseases, as well as shifting species range on designed landscapes, parks and gardens.

In some situations, loss will arise from the need to take hard decisions about where best to focus our limited resources, whilst in others it may not be feasible or desirable to protect the assets *in situ* or to move them to a safer location. If managed positively and proactively the loss of historic assets can still yield valuable information to add to our understanding and appreciation of the historic environment. This process of managed loss is also a form of adaptation.

12 IPCC, 2014: Annex II: Glossary [Mach, K.J., S. Planton and C. von Stechow (eds.)]. In: *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, pp.117–30.

4. Implementation of the sector adaption plan ¬

Sector adaptation plan ¬

This sector adaptation plan builds on the high-level strategic actions identified in the Welsh Government's adaptation plan *Prosperity for all: A climate conscious Wales*.[13] It identifies the climate change risks, opportunities and adaptation needs for the historic environment. Its aim is to stimulate action through the development of partnerships and the implementation of strategies and programmes. Table 3 in Section 6 provides a framework for coordinating this work.

The actions in Table 3 are based on the outputs of a series of workshops and discussions with stakeholders, and feedback received following public consultation of the draft sector adaptation plan in 2018–19. As adaptation is an ongoing process this will continue to be a living plan that will be improved and updated through an inclusive and iterative process.

Publication of this plan represents the 'starting' and 'investigating' stages of the adaptation cycle shown in Figure 6 below.

Figure 6: Five stages or parts of planned climate change adaptation.

13 *Prosperity for all: A climate conscious Wales*, Welsh Government, 2019 www.gov.wales/prosperity-all-climate-conscious-wales

Successful delivery of many of the actions will be best achieved through partnership working. Addressing the actions is beyond the scope of the subgroup alone. To gain traction it is essential that others pick up and implement this plan. This will require the allocation of dedicated resources, both human and financial, as well as engagement and buy-in from politicians, senior decision-makers, asset managers and policy makers.

The next step will be the 'planning' stage during which the Historic Environment Group will disseminate the plan more widely and build on the partnerships already formed during the initial work. In collaboration, we will identify lead organisations and partners to drive forward the 'implementing' stage and set timescales for delivery. This may include the establishment of separate working groups to tackle specific topics or actions. Examples of actions already being implemented are shown below.

CHERISH

CHERISH (Climate, Heritage and Environments of Reefs, Islands and Headlands) is a six-year European-funded Ireland-Wales project. It aims to raise awareness and understanding of the past, present and near future impacts of climate change, storminess and extreme weather events on the rich cultural heritage of the Irish and Welsh regional seas and coast. It employs innovative techniques — ranging from terrestrial and aerial laser scanning, geophysical survey and seabed mapping through to palaeoenvironmental sampling, excavation and shipwreck monitoring — to study and monitor some of the most iconic coastal locations in Ireland and Wales.

CHERISH began in January 2017 and will receive €4.9 million through the Ireland-Wales 2014–20 Programme. The project partners are RCAHMW; the Discovery Programme: Centre for Archaeology and Innovation Ireland; Aberystwyth University: Department of Geography and Earth Sciences, and Geological Survey, Ireland.
www.cherishproject.eu/en/

Fit for the Future

Set up and hosted by the National Trust, Fit for the Future is a UK-wide network of organisations working together to become climate friendly, adaptive and resilient. The network offers practical support, events and workshops, and encourages its members to share good practice. www.fftf.org.uk

Within the network a climate change adaptation working group is being developed. A series of workshops will help share members' approaches to climate change adaptation, and methods and tools for assessing impacts and adaptation responses at specific locations.

Shifting Shores

The National Trust, in partnership with RTPI Cymru, recently held a series of CPD events based on planning for climate change. These events explored the challenges of managing future sea level rise in sensitive coastal landscapes where nature, historic environment and people coexist.

Held at coastal locations, these events provided an opportunity to discuss both the policy context and the practical implication of rising sea levels.

Flooding and Historic Buildings in Wales[14]

This 2019 Cadw publication provides guidance on ways to establish flood risk and prepare for possible flooding by installing protective measures. It also recommends actions to be taken during and after a flood to minimise damage and risks. Aimed principally at home owners, owners of small businesses and others involved with managing historic buildings, *Flooding and Historic Buildings in Wales* explains how to approach the protection of traditional buildings and avoid inappropriate modern repairs in the event of flood damage.

Wider integration and implementation ¬

This plan encourages wider engagement and integration of historic environment considerations into policies, programmes and strategies across the sectors, thereby influencing adaptation action on the ground.

All public bodies covered by the Well-being of Future Generations (Wales) Act 2015[15] need to set and publish their objectives for sustainable development. They will need to identify opportunities to include actions from the sector adaptation plan in this process and to embed them in adaptation plans at local authority level. The public services boards must also take account of the UK Climate Change Risk Assessment in their own local well-being assessments. These should address the historic environment issues identified in this plan where they are applicable.

Implementation of the sector action plan will involve a wide range of organisations and their partners and networks. Different bodies will take the lead depending on the type of adaptive action to be taken. For example, some actions designed to increase our knowledge will involve research, desk-based analysis and fieldwork, and will appeal to a diverse range of organisations, research and educational institutions.

Taking action on the ground to build resilience in the historic environment will also involve many individuals and organisations, including voluntary groups and third sector organisations. Raising awareness and providing guidance, support and training will therefore be important tasks if this plan is to achieve a wide reach.

14 *Flooding and Historic Buildings in Wales*, Cadw, Welsh Government, 2019 www.cadw.gov.wales/advice-support/historic-assets/listed-buildings/technical-advice#section-flooding-and-historic-buildings-in-wales

15 Well-being of Future Generations (Wales) Act 2015 www.legislation.gov.uk/anaw/2015/2/contents/enacted www.gov.wales/topics/people-and-communities/people/future-generations-act/?lang=en

Monitoring and evaluation ¬

The fifth and final part of the adaptation cycle is 'monitoring and evaluation'. This will be coordinated by HEG in collaboration with the adaptation action leads. The process will be run in parallel with the monitoring and evaluation framework for the Welsh Government's national adaptation plan, *Prosperity for all: A climate conscious Wales*.[16]

HEG will report progress against the actions to the Welsh Ministers every two years and the action table reviewed and updated after five years. The sector adaptation plan and monitoring and evaluation reports will be published on the Cadw website.[17]

Parched coastal landscape of Morfa Nefyn on the Llyn Peninsula on a hot summer's afternoon during the drought of 2018.

16 *Prosperity for all: A climate conscious Wales*, Welsh Government, 2019 www.gov.wales/prosperity-all-climate-conscious-wales

17 www.cadw.gov.wales/

5. Case studies ¬

Introduction ¬

The following case studies help to illustrate the types of impacts that are already affecting the nine different categories of historic asset described in Table 1. The risks reflect the impacts identified in Table 2 and the examples of climate change adaptation are linked to the headline actions in Table 3 in Section 6. The range of actions needed for each category of historic asset is indicative and not an exhaustive list.

The categories are not wholly distinct from one another and overlap in a variety of ways. For example, settlements may be located on the coast; rivers, canals and freshwater may run through farmland, and built structures form an important aspect of designed landscapes.

These categories are intended to assist with the development of appropriate management responses and may facilitate cross-sector working. However, it is also important to recognise the close interconnection of these categories and their cumulative contribution to the historic landscapes of Wales.

Buildings and settlements ¬

Buildings and settlements comprise all historic built structures. They can range from an individual building through to a village, town or city and from a standing building, complete with its fixtures and fittings, through to a collapsed ruin or a buried and deeply stratified archaeological deposit. These historic assets may be afforded statutory protection through listing, scheduling or designation as a conservation area, but those that are not protected formally still contribute to the quality and character of the historic built environment and help to create a sense of place and local identity.

The **effects of climate change** on buildings and settlements are likely to be numerous as they are at risk from all of the observed and predicted climate change scenarios. They are particularly at risk from sea level rise, flooding, increased ground moisture and precipitation, and more frequent storm events. As a result, the frequency and extent of maintenance and repair tasks is likely to increase. The effects of climate change may be gradual or severe in the short to medium term and significant over time.

As Figure 2 shows, Wales has over 30,000 listed buildings, of which 12 per cent are in Flood Zone 3. These have a 100 to 1 chance of future flooding from rivers or a 200 to 1 chance of flooding from the sea.

Risks include:	
SL1	Sea level rise leading to inundation and flooding causing damage or loss.
SL2	Potential adverse impacts from clean-up operations and flood protection measures.
PD1	Increased incidence and severity of fungal and insect attack.
LGS1	Increased colonisation by vegetation, accelerating the decay of building materials and increasing the cost of maintenance and repair.
LEI1	Changes in lifestyle and leisure patterns increasing the pressure for development and infrastructure in coastal resorts.
DRY1	Subsidence caused by clay shrinkage.
WF1	Damage and increased risk of fire from drier conditions.
FL1	More flood events causing damage, scour and potential adverse impacts from clean-up operations.
EX1	Storm damage and increased rain, ground water and humidity impacting on the health of building fabric, occupants and collections/archives.
EX2	Impacts of extreme and fluctuating temperatures causing overheating of buildings and affecting the physical weathering characteristics of building materials. Potential for maladaptation.

Opportunities include:	
LEI2	Increased potential for heritage tourism and conservation-led regeneration, particularly in coastal resorts.
DRY4	Improved humidity levels in buildings during hotter, drier summers.
Example adaptation actions	
Knowledge	
1.3	Participation in established UK and wider climate heritage groups and networks to maximise knowledge and resources, leading to capacity building and more successful adaptation.
2.2	Establish and implement targeted monitoring regimes on buildings and settlements.
3.1	Improve understanding of the interacting, cascading and cumulative impacts of climate risk factors on building condition and fabric.
Capacity	
5.3	Prepare, promote and maintain building and settlement case studies to illustrate examples of adaptation.
6.2	Provide training and support within and across sectors on the risks and opportunities of climate change for buildings and settlements, and their adaptation.
6.3	Prepare guidance/advisory notes that increase the knowledge, understanding and resilience of buildings and settlements to climate change e.g. property flood resilience.
Resilience	
7.1	Develop and implement emergency/adaptation plans for buildings.
7.2	Undertake programme of urban characterisation to inform management of change in urban areas.
7.3	Work closely with the all-Wales monuments and listed buildings at risk monitoring work to help prioritise adaptive action.

CASE STUDY

In early January 2014 a series of storms battered Aberystwyth Promenade damaging many structures including the grade II listed **Bathrock Shelter,** which dates from the 1920s. The storm and resulting turbulent sea, combined with very high tides, breached the bastion on which the shelter sat and revealed the footings of a bathhouse associated with the Marine Baths built by Doctor Rice Williams Esquire in 1810. Loose material used as fill for the bastion was washed away and the resulting void led to the partial collapse and subsidence of Bathrock Shelter.

Adaptation: saw the removal of the shelter, its careful restoration over a strengthened and re-engineered sea wall and reinstatement by Ceredigion County Council. Emergency recording comprising detailed photography of the shelter and exposed remains of the bathhouse was undertaken by the RCAHMW.

Bathrock Shelter, Aberystwyth, damaged by a storm in 2014.

The remains of the bathhouse that were revealed beneath the shelter.

CASE STUDY

Plas Newydd is a grade I listed building and Accredited Museum sitting within a grade I registered historic park and garden. There are other listed structures and a scheduled monument, the Plas Newydd burial chamber, within the grounds.

On Boxing Day 2015 Anglesey experienced high winds and rainfall. Flood water found its way into the basement where the mains electric switch panel was located. Water was waist deep and although none of the collection or building fabric was seriously harmed, the mansion's electricity supply was damaged irreparably. As a result, the mansion was without full power for a period of four weeks, staff flats had to be vacated and a private security firm employed while the building was unoccupied. As a temporary measure, sand bags were put in place to divert flood waters into a drain, the cover for which has since been replaced with a grille.

In November 2017 another, more severe, storm occurred. On this occasion, however, there was more extensive wind and water damage to the gardens around the mansion with landslips resulting in the loss of paths and storm damage to trees.

Adaptation: A more robust emergency plan has been implemented, the mains electricity switch panel was relocated and the drainage and maintenance regimes were reviewed to improve flood/storm alleviation and defence measures. The effectiveness of this plan was demonstrated in November 2017. Although flood water once again entered the basement, and worked its way into the house itself, the emergency plan ensured that the power was switched off before the supply could be damaged.

Following the November storm, a more detailed survey has been undertaken to look at further options for flood alleviation and defence measures. Management of a shelter belt on neighbouring land has also been discussed to help prevent further wind damage.

Flood water being channelled along the ha ha.

Water penetrating the cellar areas.

Damage to the paths.

Marginal and upland ¬

Due to a lack of intensive farming and the organic preservation of waterlogged remains in peat, peat soils and raised bogs, **marginal and upland** areas include extremely well-preserved buried archaeology and earthworks, including some of the best-preserved prehistoric ritual monuments in Wales.

Peatlands are valued for their landscape character and features associated with past cultural activities such as peat cutting. Peat is also a precious paleoenvironmental resource holding information on past climate conditions and the local environment. Wales has an estimated 70,000 hectares of upland peat bog, which stores significant quantities of carbon; healthy peat bogs remove between 30 and 70 tonnes of carbon per square kilometre.

The **effects of climate change** on marginal and upland areas will be numerous as they are at risk from many of the observed and predicted impacts of climate change. The effects may be gradual or severe in the short to medium term and significant over time.

The wildfire in August 2018 caused catastrophic damage to 250 hectares on Llantysilio Mountain, part of the Clwydian Range and Dee Valley Area of Outstanding Natural Beauty.

Emergency services responding to the wildfire on Llantysilio Mountain.

Risks include	
PD2	Proliferation and expansion in range of invasive and non-native (INNS) species.
LGS1	Warmer mean temperatures leading to longer growing seasons and the expansion of improved pasture and cultivation into the uplands having a negative impact on historic assets above and below ground.
LEI1	Warmer mean temperatures leading to increased visitor pressure on historic upland areas.
DRY2	Conditions too dry for the growth of lowland mire, making historic assets increasingly vulnerable to degradation.
DRY3	Drying out and erosion of peats and peaty soils, threatening a large proportion of Wales's significant archaeological remains and paleoenvironmental resource. The loss of the organic content of peaty soils transforming the types of vegetation and changing the historic character of peatland. Changing land use to cope with water shortages, lack of fodder and poor harvests.
WF2	Hotter, drier summers leading to increased risk of erosion and subsequent loss of peat as a paleoenvironmental record resulting from fire damage to surface vegetation and its protective effect.
FL2	Increased risk of physical (mechanical) damage through the use of agricultural machinery on waterlogged soils, including 'poaching' by livestock near historic assets. Persistent saturation resulting in chemical changes to buried archaeology.
FL3	Destabilisation and subsidence of archaeological deposits and earth structures leading to slippage or collapse.
EX1	Storm damage to features and structures above ground.
EX2	Impacts of extreme and fluctuating temperatures affecting the physical weathering characteristics of building materials. Changing land use to cope with the impacts of extreme and fluctuating weather conditions.

Opportunities include	
LEI2	Potential opportunities from increasing visitors and heritage tourism, including conservation-led regeneration.
DRY4	Hotter, drier summers leading to the discovery of new historic assets in desiccated grassland and crops visible as parch and crop marks.
Example adaptation actions	
Knowledge	
2.1	Carry out spatial mapping work to identify marginal and upland areas at greatest risk and analysis of specific impacts on those assets at greatest risk.
3.1	Improve our understanding of the proliferation and expansion in the range of invasive and non-native (INNS) species and changing land use that could result in a cumulative loss of landscape character.
Capacity	
5.3	Prepare case studies to further illustrate climate change risks and adaptation in marginal and upland areas.
6.3	Prepare guidance/advisory notes to increase our knowledge, understanding and resilience of marginal and upland areas to climate change e.g. land management to reduce the impact of wild fires on buried archaeology and loss of peat as a paleoenvironmental record.
Resilience	
7.1	Work with agricultural advisors to limit adaptations that have potential to damage historic assets e.g. deeper root crops.
7.3	Survey vulnerable areas where drying and shrinkage of peat affects historic assets.
7.4	Establish stakeholder/community groups able to monitor and record assets and respond to significant events such as wild fires.

CASE STUDY

Waun Fignen Felen is an important Mesolithic archaeological site, a place used over several millennia as a hunting location by populations exploiting the uplands. The blanket bog and upland raised bog are significant for biodiversity and for prehistoric cultural palaeoenvironmental evidence. But the bogs are drying out and this contributes to high levels of peat erosion, as shown by the columns of peat which identify the height of the original bog surface, and the bare peat that demonstrates ongoing erosion.

Adaptation: The Brecon Beacons National Park Authority and the Waun Fignen Felen Management Forum are working to restore favourable hydrology to conserve and enhance biodiversity and the archaeological and paleoenvironmental values of the site. An archaeological assessment will inform and support the conservation programme.

Waun Fignen Felin peat erosion channels contrasting with the ongoing conservation restoration work within the site.

Peat haggs and eroding peat fans at Waun Fignen Felen.

Marine and coastal ¬

Marine and coastal landscapes include those historic assets relating to maritime activity and coastal defence. They are located on the seabed and foreshore, on cliff edges, the coastal plain and in other areas, such as sand dunes. The sea has played a significant role throughout human occupation and, whilst the shoreline may change, the sea has enabled communication, provided food for people and a means of defence, evidence for which is found along our shores.

Wales has a coastline over 2,700 kilometres long containing over 100,000 historic assets of all periods and types: 16 per cent are at risk from sea level rise.

The sea plays a crucial role in climate change. The **effects of climate change** are evident in the expansion of the oceans and melting of the ice sheets which are causing sea levels to rise. These processes are exacerbated by increased storm events. Whilst submergence of archaeological evidence will impact upon the historic environment, it may not result in complete destruction of the evidence. However, erosion of historic assets from turbulent seas and increased storminess can have a more profound impact. Though the scale of vulnerability of marine and coastal landscapes may differ, all are vulnerable to some extent, with glacial deposits and sand dunes particularly prone to change. Ocean acidification is also changing the chemistry of seawater making marine ecosystems and historic assets such as shipwrecks more vulnerable to risks such as invasive species.

Risks include	
SL1	Submergence or loss of historic assets and landscapes through sea level rise. Negative impact on tourism following closure/damage to historic assets.
SL2	Potential adverse impacts from clean-up operations and flood protection measures.
PD2	Change in marine species in response to warmer seas and increased acidification.
LGS1	Introduction of new species altering the distinctive historic character of the marine and coastal environment.
LEI1	Increased pressure for development and infrastructure in coastal resorts as a result of migration from urban centres and increased visitor numbers.
DRY2	Increased movement of sand dunes leading to exposure and damage of formerly buried deposits.
FL1	Prolonged heavy rain leading to landslips.
EX1	Storm damage to historic assets and erosion of coastal edge from wind and wave action. Potential adverse impact from clean-up operations and modifications.
Opportunities include	
LEI2	Increase in visitor numbers to coastal resorts and heritage tourism, including conservation-led regeneration.
EX3	Discovery of new sites following exposure by coastal erosion or movement of sediment.
Example adaptation actions	
Knowledge	
2.1	Carry out spatial mapping work to identify historic assets at greatest risk.
3.1	Improve understanding of the impacts of acidification of seawater and changing marine species on wrecks and timber structures in marine environments.

Capacity	
5.2	Work with local and national authorities to ensure the historic environment is included within management of the coastal zone policy statements, plans and codes.
6.1	Provide support and training for historic environment practitioners wishing to specialise in the impacts of climate change and adaptation of historic assets.
Resilience	
7.1	Prepare and implement emergency/adaptation plans for sites at risk from erosion.
7.3	Survey or excavate sites at risk.
7.4	Establish stakeholder/community groups able to monitor and record assets and respond to significant events such as wild fires.

CASE STUDY

The scheduled monument of **Dinas Dinlle** is a dominant hillfort lying on the north Gwynedd coast on the top of glacial moraine, designated as a Site of Special Scientific Interest for its geological significance. The site has been subject to extensive erosion. The impact of heavy rainfall, as well as wind and wave action during storms has resulted in over 50 metres of the western side of the monument being lost since 1900. The outcomes of climate change will lead to more rapid erosion of the monument, which could be entirely lost over the next few centuries.

Adaptation: The monument is owned by the National Trust and their Coastal Adaptation Strategy involves 'embracing the inevitable'. Whilst no active intervention is planned to stop erosion, a series of adaptive actions are taking place, including the construction of wooden pathways to control erosion and a fence along the edge of the cliff, plus the repair of other footpath erosion.

New research led by a team of archaeologists, surveyors, geographers and scientists from the European-funded CHERISH Project began in 2017. This has included survey of the eroding cliff face, a programme of geophysical survey and archaeological excavation. The latter resulted in the discovery in 2019 of two sides of a well-preserved stone structure, buried under sand. The structure is interpreted as a round house approximately 13 metres in diameter, with stone walls surviving 3 to 4 courses high and 2.4 metres wide. A possible second round house was identified to the south.

The eroding cliff face of Dinas Dinlle coastal hillfort, Gwynedd.

South face of the north wall of the round house.

Rivers, canals and freshwater ¬

Freshwater landscapes include those historic assets associated with water management, water transport, energy production, food resources and drinking water. Humans have always found it necessary to create and adapt water management systems for all sorts of purposes so that the historic assets associated with these processes reflect the wide range of approaches that have been adopted.

The **effects of climate change** are evident through increased flooding, flash flood erosion, high water tables and abandonment of frequently flooded areas. Heavy and prolonged rainfall has caused severe flooding in recent years, and persistent exceptional weather events suggest this trend will continue. Events of this type tend to be sudden and catastrophic, but adaptations can include improved flood defences and increasing the resilience of structures. All historic assets which lie within a potential flood zone are at risk, but particularly within fast-flowing water. Historic bridges, weirs, fish traps, quays and jetties are typical examples of high-risk assets. However, the wider flood zone can also include houses and industrial buildings, as well as entire historic settlements.

The opposite effect from drying out of water courses and lakes during hotter, drier summers also carries numerous risks, including drying and shrinking of clay soils, changes in agricultural practices, loss of paleoenvironmental evidence and impacts on planned landscapes and gardens.

Rainfall in Wales varies from more than 3,000 millimetres per year in Snowdonia to less than 1,000 millimetres per year on the coast edge. Periods of prolonged rainfall (such as those in 1987, 2000, 2004, 2012) can lead to widespread flooding. Over 3,500 historic assets are included within potential flood zones.

Risks include	
SL1	Rise in sea level and storm surges exacerbating risk of flooding and damage to historic assets from overflowing rivers.
PD2	Proliferation and expansion in range of invasive and non-native (INNS) species.
LGS1	Increased vegetation cover, obscuring historic assets and accelerating decay of building materials, resulting in increased maintenance and repair costs.
LEI1	Increased visitor pressure on historic freshwater landscapes.
DRY1	Subsidence caused by clay shrinkage to features and structures e.g. buildings, flood defences, dams, reservoirs and river banks, blockages of river courses.
DRY2	Erosion of historic assets exposed by the lowering of lake, inland waterways and river levels. Destabilisation and erosion of earth structures, embankments and cuttings.
DRY3	Operating historic water mills at risk from water shortage.
FL1	Increased flood risk from overflowing rivers and damage to historic fabric during response and clean-up operations. Structural damage or loss of riverside structures from erosion, impact from debris and scour caused by flash floods.
EX1	Storm damage to historic buildings and structures, resulting in increased maintenance and repair costs.
EX2	Potential direct and indirect impact from extreme and fluctuating weather conditions affecting the physical weathering of building materials and exacerbating structural problems.
Opportunities include	
LEI2	Increase in heritage tourism, leisure and recreational activities.

Example adaptation actions	
Knowledge	
2.1	Carry out spatial mapping work to identify assets at greatest risk from flood events and increased scour, using evidence including the flood zone mapping.
3.1	Improve understanding of the interacting, cascading and cumulative impacts of climate risk factors on building condition and fabric.
Capacity	
5.2	Work with relevant authorities to ensure the historic environment is taken fully into account when planning improved flood defences.
6.3	Develop advice and guidance on the maintenance and repair of historic buildings and structures to increase their resilience, and on post-flood clean-up operations.
Resilience	
7.1	Prepare and implement emergency/adaptation plans for sites at risk from flooding.
7.3	Survey or excavate sites at risk.
7.4	Establish stakeholder and community groups to help monitor and respond to the risks and their impacts.

CASE STUDY

The Monmouthshire and Brecon Canal, opened in 1812, is mostly an unlined 'side-long' contour canal within the Brecon Beacons National Park. Over the winter of 2013–14 excessively heavy rainfall led to the settlement of a 125 metres length of embankment crest above Llanfoist, causing a tension crack of around 150 millimetres wide and settling at the worst point by 700 millimetres. A secondary slip occurred a further 300 metres from the original site. There were three properties at risk at the bottom of the embankment.

Following site visits and investigation of the geology, the cause of the settlement was thought to be related to the makeup of the embankment and the natural interface with the rock. The soil had become saturated and lost cohesion between the channel and bedrock, causing the embankment to settle along the weakest points, this being the channel lining.

The canal was closed and drained due to the loss of support to the canal lining. The immediate concern was that the concrete lining did not have enough support to hold itself and that it could fracture and cause a breach.

Adaptation: Repairs were carried out by grouting the longitudinal crack and installing 500 soil nails of up to 19 metres in length, with structural plates and netting to secure the embankment face to the underlying rock. The embankment crest was then raised using a low-weight fill, and the towpath reinstated.

Similar problems will be averted in future by concrete lining vulnerable embankments, which will also reduce leakage and therefore water demand, or rebuilding with a reinforced earth structure, depending on the circumstances.

Following the failure, academic research was commissioned to confirm the failure mode and its link to climatic conditions. Slope deterioration and resultant failures have a significant negative impact on transport networks. An important driver to this loss of performance is weather-driven annual cycles of pore pressure change, and anecdotal evidence suggested that extreme weather events contribute to the occurrence of failure. The potential impact of climate change on the rate of deterioration and incidence of sudden failure needed to be considered.

iSMART, a collaborative research project funded by the UK Engineering and Physical Sciences Research Council, as yet unpublished, concluded that weather-driven deterioration of soils exists and that climate change is likely to accelerate that deterioration. The research developed prototype modelling tools to assess future deterioration of transport earthworks.

The team is actively pursuing ways to take the iSMART research further, both in terms of application of the developed tools and techniques to practice, and the further investigation of deterioration, making explicit its links to the business case for improved design, monitoring and maintenance of assets.

Grounding slumping away from the concrete lining of the canal near Tod's Bridge.

A further slip towards Govilon.

Repairs to the embankment near Llanfoist.

Farmland ¬

Farmland includes archaeological sites, buildings such as farmsteads and their associated farm structures, and agricultural landscapes whose character may be strongly influenced by historic field systems and boundaries.

Farms and commons account for 1.8 million hectares, 88 per cent of Wales. The total number of traditional farm buildings in Wales is unknown, but is likely to exceed 100,000. At least 2,500 agricultural buildings are listed, nationally valued for their architectural and historic interest. 13,894 earthwork sites and 5,264 buried archaeological sites are recorded on agricultural land. Historic assets may be above or below ground, well preserved, in use or ruined.

The **effects of climate change** may threaten historic assets on farmland both directly and indirectly, often exacerbated by the extremes of desiccation and flooding. More flooding events, increased ground moisture and precipitation, and an increased frequency and intensity of storms may erode farmland earthworks and archaeological deposits, as well as damage structures.

An extended growing season and warmer conditions may intensify farming and introduce new crops and renewable energy. It may also change farming practices by, for example, increasing cereal and bio-energy crops, and expanding improved pasture into moorland fringes. More frequent ploughing of cultivated land and ploughing fields not recently cultivated may impact adversely on buried archaeological assets. Drying out of waterlogged deposits may result in decomposition and subsequent erosion. The increased prevalence of pests and diseases may also have adverse impacts.

Glantowy Fawr farmhouse and farm on the floodplain of the River Tywi showing the effects of increased rainfall on historic assets.

The LANDMAP historic landscape dataset for Wales identifies that irregular fieldscapes account for 42 per cent of Wales and regular fieldscapes 17 per cent. 430 historic character areas were associated with bank boundaries and 1,380 with hedged boundaries. These are traditional boundary types that are important historically and contribute significantly to the historic landscape character, but may be affected adversely by climate change.

Caer Leb, Brynsiencyn earthwork settlement enclosure show the effects of increased rainfall on historic assets.

Buried archaeological assets, such as the Croes Carn Einion Roman villa cropmark complex, are vulnerable to intensified cultivation in warmer climes.

Risks include	
PD2	Adverse impacts of pests and diseases on historic fieldscapes and living field boundaries.
LGS1	Intensification of farming, expansion of improved pasture into moorland fringes and introduction of new crops and renewable energy structures with adverse impacts on historic assets. Changes in agricultural practices and land use may favour the removal of traditional field boundaries. Adverse impact on buried archaeological assets from more frequent ploughing and ploughing of fields that have not been cultivated recently.
DRY2	Increased erosion from impaired pasture growth caused by desiccation and increased use of marginal pastures leading to erosion of archaeological remains.
DRY3	Drying out of waterlogged deposits leading to erosion and damage to farmland earthworks, archaeological deposits and structures. Changing land use to cope with water shortages, lack of fodder and poor harvests.
FL2	Increased risk of physical (mechanical) damage through the use of agricultural machinery on waterlogged soils, including 'poaching' by livestock near historic assets.
FL3	Destabilisation and subsidence of archaeology on designed features, archaeological deposits and earth structures leading to slippage or collapse.
EX1	Storm damage to features and historic buildings, resulting in increased maintenance and repair costs.
EX2	Potential direct and indirect impacts from extreme and fluctuating weather conditions resulting in increased physical weathering and structural problems in traditional farm building materials. Changing land use to cope with the impacts of extreme and fluctuating weather conditions.
Opportunities include	
DRY4	Predicted hotter, drier summers present the opportunity for the discovery of new historic assets in desiccated grassland and crops, visible as parch and crop marks
Example adaptation actions	
Knowledge	
2.1	Carry out spatial mapping work to identify farmland assets at greatest risk.
2.2	Resource aerial reconnaissance programmes and the capacity to react swiftly to weather events for the enhancement of the National Monuments Record of Wales and historic environment records of Wales.
Capacity	
6.2	Provide training and support within and across sectors on the impacts of climate change and adaptation of the historic environment.
6.3	Prepare updated best-practice agri-environment and historic environment guidance to encompass climate change risks and recognition that adaptation will be a continuous process. Convey how stable, well-managed grass swards can be beneficial to archaeological sites and promote this where appropriate.
Resilience	
7.3	Support climate change adaptation through the new sustainable farming scheme for Wales.
7.5	Encourage the re-planting of fieldscape trees and gaps in hedgerows where they form a key component of the historic landscape to reduce the impact of disease and storm losses.

CASE STUDY

Over a three-week period during the summer drought of 2018, the Royal Commission on the Ancient and Historical Monuments of Wales (RCAHMW) aerial archaeologist captured around 4,000 high resolution images which resulted in the discovery of approximately 100 new historic assets.

This new evidence enhances our knowledge and understanding of the historic environment, provides new resources for future research and contributes to the historic environment record.

Severe drought in 2018 at a known prehistoric settlement in the Vale of Glamorgan showed new crop marks of a probable Roman villa within its modified ramparts.

Woodland ¬

Woodland covers 14 per cent of Wales and contributes to the distinctive historic landscape character, heritage and culture of Wales. Wooded landscapes, patchworks of small and scattered woodlands, and hedgerow trees are often key visual and cultural elements within registered historic parks and gardens and registered historic landscapes. The Welsh public forests alone include 207 scheduled monuments, 44 listed buildings and over 7,600 features of archaeological interest.

Less than 5 per cent (94,940 hectares) of Wales is ancient woodland, areas that have been continuously wooded since 1600AD. Ancient woodlands, veteran trees and hedgerows are important historic assets and contain evidence of past human use associated with the development and management of woodland. Preserved historic sites may predate the woodland, often surviving as ruined structures, earthworks and buried archaeology.

The **effects of climate change** on woodlands and trees may be gradual, but significant over time. The predicted effects of soil erosion, land-use change and slope instability could all damage individual historic features. The risk and vulnerability of trees and woodland from pests, pathogens and invasive species may be increased by stress from changing conditions and the frequency and magnitude of extreme weather and wild fire events. The predicted change in the distribution of tree species will cumulatively, if not individually, have an impact on our wooded landscapes.

The Lower Wye Valley registered historic landscape with its characteristic woodlands, ancient woodland and diverse historic assets.

Risks include	
PD2	Proliferation and expansion in range of pests, pathogens and invasive and non-native (INNS) species.
PD3	Changes in the distribution of tree species and loss of species already at their threshold of tolerance.
DRY2	Soil erosion, land-use change, and slope instability could all damage individual historic features within woodlands.
DRY3	Drying and stress to veteran trees, historic woodland and the setting of historic assets. Changing use of woodland on agricultural land to cope with water shortages, lack of fodder and poor harvests.
WF2	Wild fires leading to alterations in the ecology, vegetation and historic landscape character.
EX2	Storm damage to veteran trees and woodland. Changes in the frequency and magnitude of high winds causing more damage from wind blow affecting built and buried archaeology.

Example adaptation actions	
Knowledge	
3.3	Improve understanding of the positive and negative effects of a longer growing season on the maintenance and management of the historic environment.
3.4	Increase our understanding of the threats and opportunities from a changing climate to new woodland planting by using UKCP18 projections.
Capacity	
6.3	Promote best-practice guidance on making woodlands more resilient. www.naturalresources.wales/guidance-and-advice/environmental-topics/woodland-management/planning-for-the-future/making-woodlands-more-resilient/?lang=en
Resilience	
7.3	Management to increase the tree species composition and genetic diversity to improve woodland resilience to climate change. The Woodlands for Wales strategy advocates increased use of low impact silvicultural systems (LISS) to diversify the structure of our woodlands and their ability to adapt to changing conditions, offering potential benefits for historic assets such as earthworks and structures within woodlands.
7.5	Encourage and implement new planting regimes where trees and hedgerows form a key component of the historic environment to reduce the impact of the spread of disease and increased storminess.

CASE STUDY

The **Cwm Einion and Upper Rheidol Forest Resource Plan** is an example of Natural Resources Wales's new minor species programme for restocking the Welsh Government woodland estate. The resilience of the woodland is improved by planting a more diverse range of species, selected on the basis of soils, climate change and other relevant factors.

Objectives in the plan relating to heritage include protecting scheduled monuments and historic features when carrying out forest management operations and keeping scheduled monuments clear of tree and scrub vegetation. Such maintenance may increase with the proliferation and expansion in invasive species. Changes in the frequency and magnitude of high winds may also cause more damage from wind blow requiring forest interventions that may affect built and buried archaeology.

CASE STUDY

The spread of Ash Dieback is now present across the whole of Wales and will have a major impact on the landscape. The Welsh Ministers have established a stakeholder **Ash Dieback Core Strategic Group**. The group will review the Ash Dieback Action Plan and ensure that the developing research and management options are communicated across the range of sectors. Research indicates that 5 per cent of ash is likely to be tolerant to Ash Dieback. Natural Resources Wales will be developing guidance on management of the disease, which will cover forestry activities, surveillance to inform planning and appropriate responses.

Storm levelled woodland, Trawscoed 2018.

Wild fire at Cwm Rheidol, 2018.

Industrial landscapes ¬

Industrial landscapes comprise the above and below ground remains of industrial activity. This includes the quarries, mines and tips resulting from the process of extraction, standing and ruined buildings, and structures which form part of the manufacturing process as well as associated worker settlements. These remains can form extensive industrial landscapes, such as the slate quarries of Snowdonia or the iron and coal works of the Blaenavon Industrial Landscape World Heritage Site in south-east Wales.

The effects of climate change on industrial landscapes will be numerous. Industrial buildings and structures are at potential risk from many of the same threats as buildings and settlements, but there are also specific impacts for this asset type, such as contamination and pollution, the destabilisation of tips and the collapse of mine workings and shafts. The effects of climate change may be gradual or severe in the short to medium term and significant over time.

Risks include	
SL1	Rise in sea levels leading to flooding and loss of coastal industries and installations.
PD2	Proliferation and expansion in range of pests, pathogens and invasive and non-native (INNS) species.
LGS1	Introduction of new species altering the distinctive historic character of industrial landscapes. Increased colonisation of buildings and structures by vegetation, accelerating the decay of building materials and increasing the cost of maintenance and repair.
LEI1	Increased visitor numbers and pressure on industrial landscapes.
DRY1	Subsidence caused by clay shrinkage to features and structures e.g. buildings, shafts and underground workings.
DRY2	De-stabilisation of tips and industrial remains leading to landslides and increased potential for pollution. Wind-blown contamination and pollution from metal mine sites, tips and settling ponds.
DRY3	Changing decay and survival of organic artefacts e.g. trackways, peat processing sites, timber launder systems. Operating historic water mills at risk from water shortage.
FL2	Persistent saturation resulting in chemical changes to buried archaeology.
FL3	Subsidence and destabilisation of workings as a result of warmer wetter winters. Flooding events, increased ground moisture and precipitation leading to pollution.
EX1	Storm damage resulting in increased maintenance and repair costs.
Opportunities include	
LEI2	Potential opportunities for increased visitor numbers and heritage tourism.
DRY4	Exposure of industrial remains, such as prehistoric mining remains and smelting sites buried beneath redeposited peaty sediments.
Example adaptation actions	
Knowledge	
2.1	Improve baseline data, particularly those underrepresented in the record, such as underground remains.
3.1	Improve understanding of the interacting and cascading relationships, and cumulative impacts of climate risk factors on pollution from historic metal mining.
Capacity	
5.3	Prepare case studies to further illustrate climate change risks and adaptation in industrial landscapes.
6.3	Prepare guidance/advisory notes that increase the knowledge, understanding and resilience of industrial landscapes to climate change.
Resilience	
7.3	Work closely with Natural Resources Wales during remediation schemes to record and, where possible, conserve archaeological remain.

CASE STUDY

Wales has around 1,300 abandoned metal mines and these have left distinct marks on the landscape; many cause pollution to rivers and streams. Wetter winters and more frequent extreme weather are likely to increase pollution and therefore mitigation and adaptation measures are essential, for example, as seen at Frongoch metal mine near Aberystwyth. **Frongoch** was once one of the largest lead and zinc mines in mid-Wales employing over 300 miners at its height in 1881.

Adaptation: Work by Natural Resources Wales to tackle pollution from the mine was completed in June 2015 at a cost of £1.15 million. It included diverting streams away from the mine and capping contaminated mining waste with soil and clay. This work was undertaken in close collaboration with archaeologists to record and conserve the archaeological remains where possible.

Excavation of a buddle at Frongoch. A buddle formed part of the process of recovering metal ore from waste.

Designed landscapes, parks and gardens ¬

Designed landscapes, parks and gardens include extensive landscaping and earthworks such as prospect mounds and terraces, built structures and ornamental buildings like grottos and follies. They are valued for the integration of the natural environment including water features, lakes, ponds, rivers and streams, native and exotic plantings and veteran trees.

The effects of climate change will be many and varied. There are currently nearly 400 registered historic designed landscapes, parks and gardens in Wales. Over half of them could be affected by coastal and inland flooding. While some exotic, heat-loving plants may benefit from warmer conditions and an extended growing season, it is predicted that warmer average temperatures will lead to significant threats associated with the migration and proliferation of pests, diseases and invasive species. There is a high risk of the loss of species already at the threshold of tolerance, and a threat to a wide range of species from Phytophthora. This will lead to changes in the distinctive character of historic parks and gardens.

Warmer temperatures can promote changes to lifestyle and leisure patterns, people seeking more pastimes outdoors potentially leading to increased visitor numbers. Earlier flowering and later leaf fall associated with warmer temperatures can also extend the visitor season. While this is good for 'business' some adaptation will be needed to tackle increased visitor pressure.

Hotter, drier summers will provide the opportunity to discover new features in our parks and gardens (parch marks), but will inevitably lead to risks of drying of soils and stress to veteran trees.

Warmer, wetter winters will lead to more flooding events, increased ground water and precipitation. While more frequent storm events will result in damage caused by frequent high winds, rainfall and extreme drought and cold events.

The effects of climate change may be gradual or severe in the short to medium term and significant over time.

Risks include	
PD2	Proliferation and expansion in range of invasive and non-native (INNS) species.
PD3	Loss of species already at threshold of tolerance leading to changes in distinctive character. Wide range of species susceptible to Phytophthora in some gardens.
LEI1	Increased visitor pressure.
DRY3	Drying and stress to veteran trees, historic woodlands and their contribution to setting.
WF1	Wild fires causing damage to buried and above ground archaeology, buildings and structures.
WF2	Changes in species leading to alterations to the ecology, vegetation and historic landscape character.
FL1	Destabilisation and subsidence.
FL2	Increased risk of physical (mechanical) damage through the use of agricultural machinery on waterlogged soils including 'poaching' by livestock near historic assets.
FL3	Potential adverse impact from clean-up operations.
EX1	Direct impact from storms causing damage to veteran trees and woodland.
EX2	Increased heat and drought impacting on veteran trees and woodland.
Opportunities include	
LGS2	Earlier flowering and later leaf fall potentially increasing visitors.
LEI2	Potential opportunities from increasing visitors and heritage tourism, including conservation-led regeneration.
DRY4	Discovery of new historic assets in desiccated grassland and crops visible as parch and crop marks.

Example adaptation actions	
Knowledge	
2.1	Carry out spatial mapping work to identify parks and gardens at greatest risk and analysis of specific impacts on those at greatest risk.
3.1	Improve our understanding of the proliferation and expansion in the range of invasive and non-native (INNS) species.
3.3	Improve our understanding of the consequences of changing growing conditions for the maintenance and management of sites and landscapes.
Capacity	
6.3	Provide guidance for post-damage clean up. Promote best-practice guidance to encourage management practices which are beneficial to designed landscapes.
Resilience	
7.1	Prepare and implement emergency/adaptation plans for vulnerable sites.
7.3	Management to increase the tree species composition and genetic diversity to improve woodland resilience to climate change.
7.5	Encourage and implement new planting regimes where trees form a key component of the designed landscape to reduce the impact of the spread of disease and increased storminess.

CASE STUDY

Prolonged rainfall caused flooding within the historic garden of **Plas Cadnant** in December 2015. As field drains blocked, overland flow was funnelled into a natural valley, sweeping away paths, damaging plants and causing the collapse of the south wall of the large walled garden.

Adaptation: This has taken the form of installing new drainage and re-laying the former gravel paths with tar and chippings. The nineteenth-century stone wall has been rebuilt with a reinforced concrete core clad with stone. Two flood holes have been designed into the base of the wall.

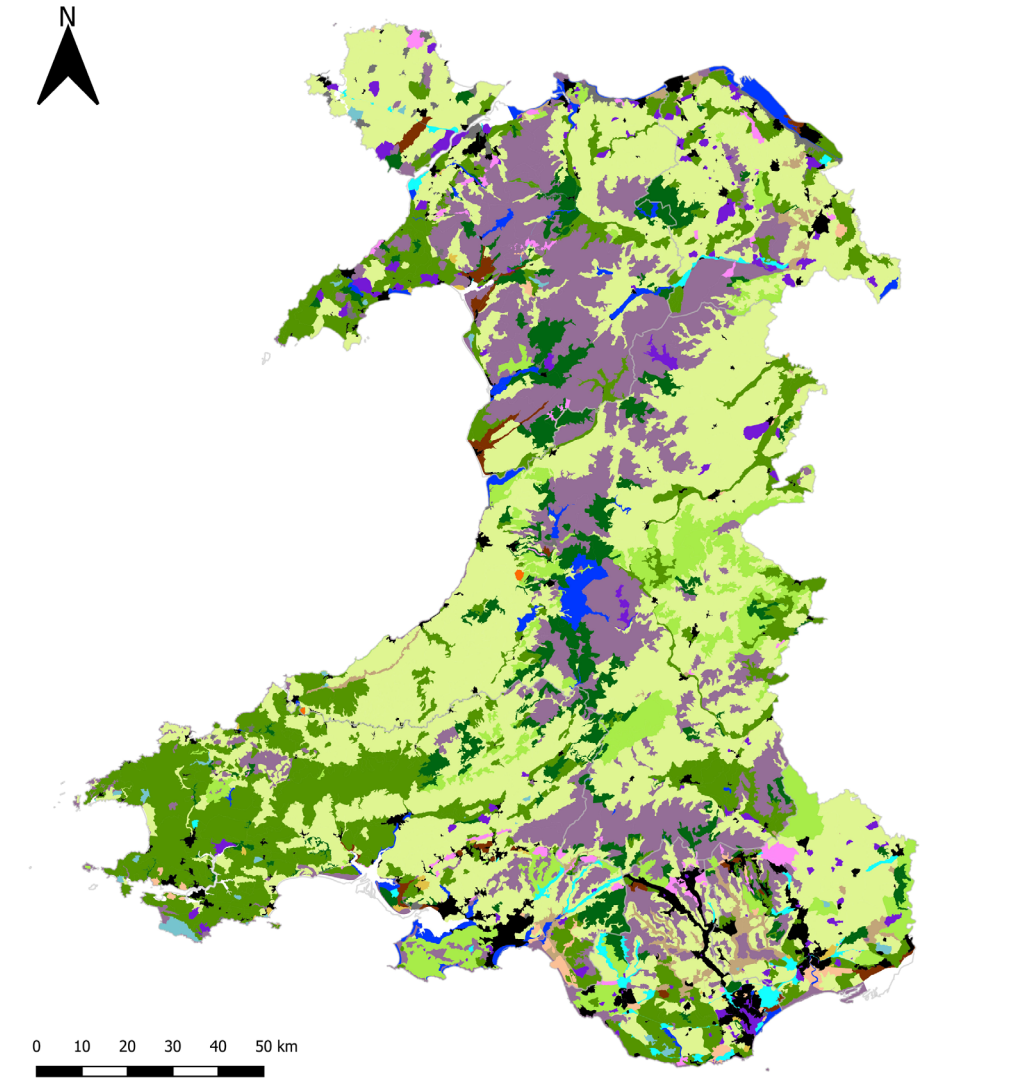
Plas Cadnant walled garden following flooding.

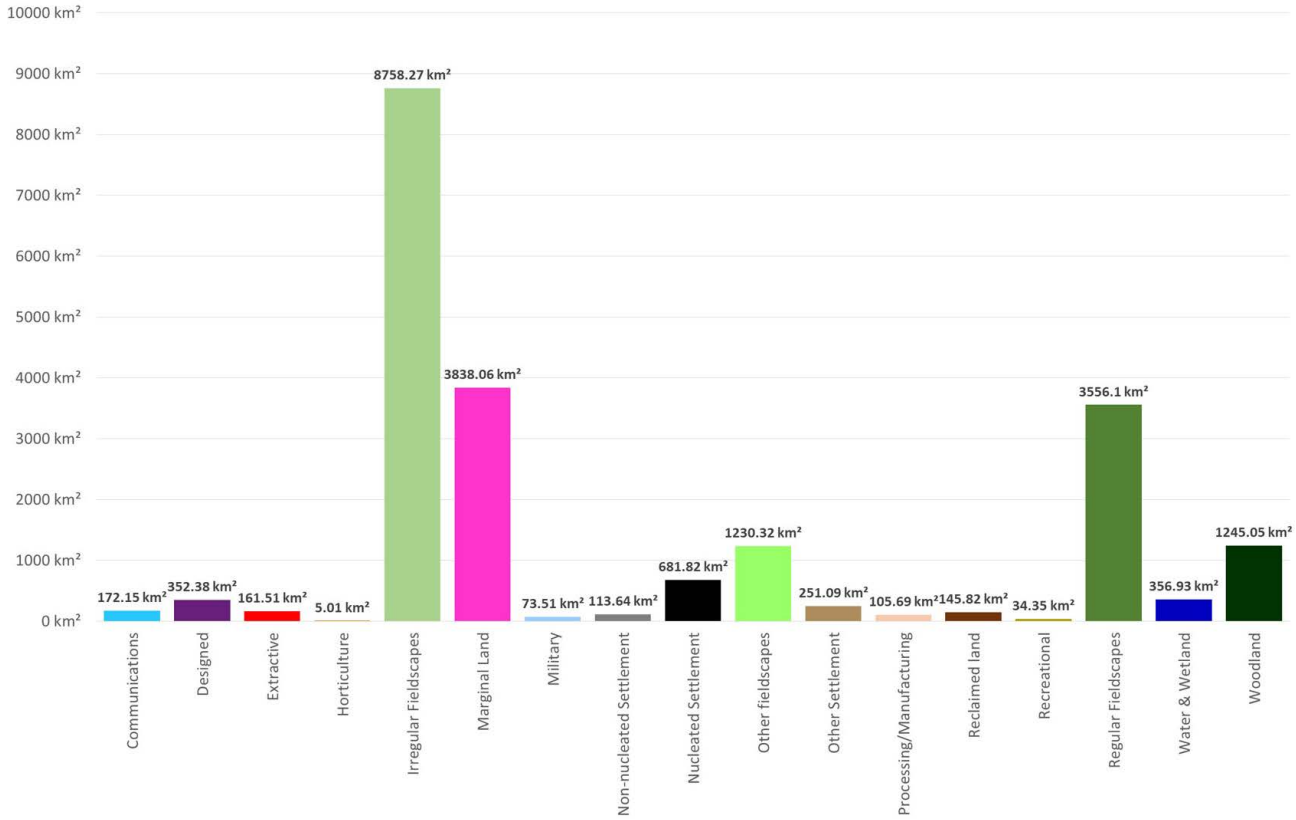
Adapted replacement stone wall at Plas Cadnant.

Historic landscapes ¬

Historic landscapes have been shaped by human interaction over the last 10,000 years through the creation of historic settlements, upland landscapes, farmland and woodland mosaics, fieldscapes and industrial landscapes. Historic landscapes often provide context and meaning to individual historic assets.

The register of landscapes of historic interest in Wales identifies 58 landscapes of outstanding or special historic interest. These are considered to be the best examples of different types of historic landscapes in Wales. For an all-Wales perspective the LANDMAP historic landscape character areas convey the diversity of Wales's rich landscape inheritance. This is shown in the map and bar chart below where irregular fieldscapes account for 42 per cent of Wales, marginal land 18 per cent and regular fieldscapes 17 per cent. Adaptation responses to climate change may be specific to historic assets at a local level, some may be landscape-scale adaption plans. By using landscapes, we can raise awareness of the challenges and opportunities from the changing climate; landscapes can provide a basis for discussions about resilience, adaption and landscape change.





Total area of LANDMAP historic landscape types in Wales.

The **effects of climate change** have been contributing to the development of historic landscapes over many millennia, both directly through their influence on land cover and indirectly by influencing land-use decisions. However, the rate of change is accelerating and this will impact on local landscape character, pattern and distinctiveness. Significant change may also occur as a result of climate change mitigation measures, such as wind farms, and adaptation through the planned expansion of woodland. Potential impacts on historic landscapes have been assessed to be moderately negative. Cumulatively however these impacts are of high significance suggesting that the impact of climate change will be more severe and widespread on historic landscapes than on any other type of historic asset.

Risks include	
SL1	Changes to coastal historic settlements and landscapes from erosion, storm surges and flooding.
SL2	Direct and indirect impact on historic coastal landscapes from increasing or strengthened engineered/physical protections.
PD2	Proliferation and expansion in range of invasive and non-native (INNS) species.
PD3	The migration of moorland habitat, western gorse and bracken to higher altitudes coupled with changing growing conditions may affect upland land use and character. Loss of species already at threshold of tolerance leading to changes in distinctive character. A wide range of species susceptible to Phytopthora.
LGS1	Introduction of new species altering distinctive historic character.
LEI1	Increased visitor pressure on historic landscapes.
DRY3	Drying and stress to veteran trees and historic woodland. Changing land use to cope with water shortages, lack of fodder and poor harvests.
WF1	Drying out of wetlands and peatland with subsequent degradation or erosion of historic assets and increased fire risk in upland environments.
WF2	Changes in species leading to alterations to the ecology, vegetation and historic landscape character.
FL1	Increasing water inundation and flooding, soil erosion and landslips in lowland historic landscapes.
FL3	Potential adverse impact from clean-up operations.
EX1	The historic character of wooded landscapes and individual trees in parkland landscapes, fieldscapes and hedgerows are at risk from storm damage pests and diseases inducing stress, dieback and loss.
EX2	Increased heat and drought impacting on veteran trees and woodland. The deterioration of traditional rural buildings may be accelerated by climate change.
Opportunities include	
DRY4	Discovery of new historic assets in desiccated grassland and crops visible as parch and crop marks.
Example adaptation actions	
Knowledge	
2.1	Carry out spatial mapping work to identify historic landscapes at greatest risk and analysis of specific impacts on those at greatest risk.
3.1	Improve our understanding of the proliferation and expansion in the range of invasive and non-native (INNS) species.
3.3	Improve our understanding of the consequences of changing growing conditions for the maintenance and management of sites and landscapes.
Capacity	
6.3	Provide guidance for post-damage clean up. Promote best-practice guidance to encourage management practices which are beneficial to historic landscapes.
Resilience	
7.1	Prepare and implement emergency/adaptation plans for vulnerable sites.
7.3	Management to increase the tree species composition and genetic diversity to improve woodland resilience to climate change.
7.5	Encourage and implement new planting regimes where trees form a key component of the historic landscape to reduce the impact of the spread of disease and increased storminess.

CASE STUDY:

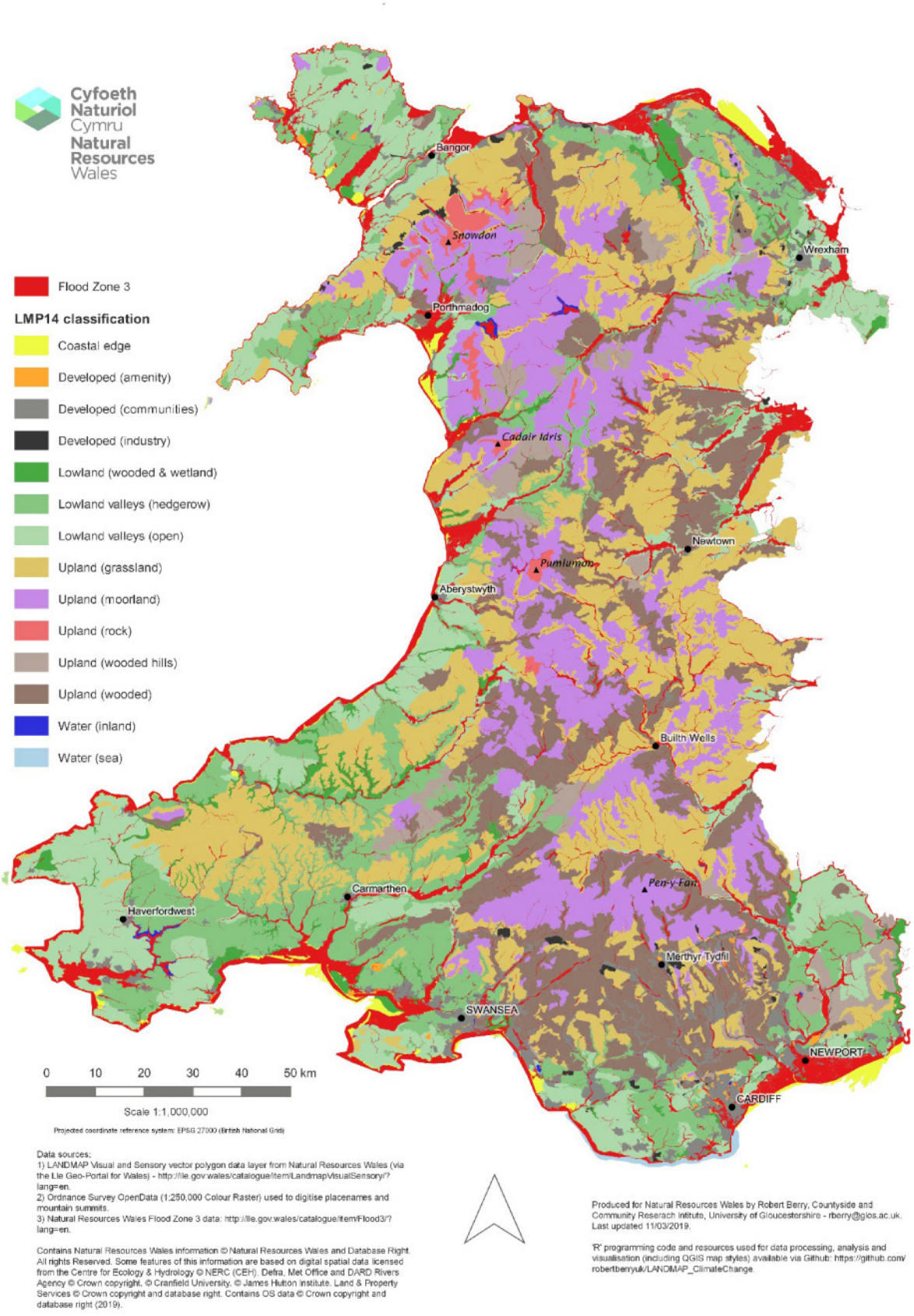
The Clwydian Range and Dee Valley Area of Outstanding Natural Beauty guidance Working with a Changing Climate[18] has adopted a place-based approach to climate adaptation. The purpose of the publication is to raise awareness and understanding of the potential effects of a changing climate and to encourage action to adapt. The guide sets out a range of issues and options to stimulate discussion.

CASE STUDY:

The report *LANDMAP, landscape & a changing climate*[19] identifies and communicates the impacts of projected climate changes for Wales in 2050 on landscape character and qualities. Mapping landscapes to impacts associated with climate change, such as flooding, provides opportunities to communicate change in a way that people understand and relate to. Landscape-based approaches can make the important connections between people and place that may be missing in other forms of climate communication. Historic landscapes provide a further perspective as they often bear evidence of past events and choices in response to climate related changes.

18 *Working with a Changing Climate: a guide to adaptation in The Clwydian Range and Dee Valley AONB*
www.clwydianrangeanddeevalleyaonb.org.uk/files/1996434094-Working%20with%20Climate%20Change%20pdf%20Eng.pdf

19 *LANDMAP, landscape & a changing climate*, Natural Resources Wales, 2019
www.cdn.naturalresources.wales/media/688650/summary-landmap-landscape-and-changing-climate-jill-bullen-nrw.pdf?mode=pad&rnd=131991937970000000
www.eprints.glos.ac.uk/6722/1/LANDMAP%2C%20Landscape%20and%20a%20Changing%20Climate_Final_Report_CCRI.pdf



LANDMAP landscape types with Flood Zone 3 data identifying landscapes at risk of flooding.

6. Actions ¬

Introduction ¬

Table 3 sets out the headline actions needed to adapt to the impacts of climate change on the historic environment of Wales. It is arranged around the three overarching and linked objectives of increasing our knowledge, increasing our capacity and building our resilience. The description of each action is accompanied by measurable outputs and broad outcomes to assist the monitoring and review of progress. Detailed mechanisms for implementing the actions and identifying delivery leads and timescales will be part of the next steps.

Table 3: Headline actions needed to adapt to the impacts of climate change on the historic environment of Wales

Knowledge: Increase our knowledge and understanding of the threats and opportunities for the historic environment from a changing climate			
	Description of the action	Output(s) from the action	Broad outcome/impact
1. Knowledge exchange/collaboration			
1.1	Dissemination, promotion and stakeholder engagement of the Historic Environment and Climate Change Sector Adaptation Plan. For example: • Communication Strategy. • Stakeholder engagement with politicians and senior decision-makers. • Monitor and evaluate strategy.	• Publication of the Historic Environment and Climate Change Sector Adaptation Plan. • Secured resources and practical actions to deliver the plan.	• Raised awareness of the challenges posed by climate change on the historic environment. • Direct action to improve our knowledge, build capacity and increase the resilience of the historic environment to climate change. • Provision of a strategic framework to take forward adaptation actions.
1.2	Establish a knowledge exchange group(s) for researchers and practitioners to share ideas, information and good practice, and to help identify future research and funding opportunities in Wales. For example: • Establish a climate and heritage management group. • Establish a spatial mapping group.	• Knowledge exchange group(s) established and active. • Identification of future research priorities for Wales.	• A coordinated approach, maximising knowledge and resources, leading to capacity building and more successful adaptation.
1.3	Participation from Wales in established UK and wider climate heritage groups and networks. For example: • Fit for the Future network. • Historic Environment Adaptation working group. • Climate Heritage Network.	• Welsh attendance at climate heritage groups and networks.	• Collaborative working maximising knowledge and resources, leading to capacity building and more successful adaptation.

	Description of the action	Output(s) from the action	Broad outcome/impact
2. Mapping and monitoring of the resource			
2.1	Improving baseline data. Develop standardised methodologies and assessment tools to both identify historic assets and prioritise those at risk. For example: • Wales spatial mapping work — including environment/asset specific mapping and analysis. • Data enhancement programmes. • Use of soil moisture indexes to target aerial reconnaissance during dry periods.	• Improved baseline data sets. • Improved consistency and comparability of data. • Publicly available and regularly updated central repository of spatial mapping datasets.	• Improved understanding of the threats and opportunities for the historic environment from a changing climate. • Improved evidence base for monitoring, statutory protection, decision-making and adaptation strategies.
2.2	Establish and implement targeted monitoring regimes on identified historic assets. For example: • Develop and publish case studies to outline different monitoring approaches to ensure consistency of data and approach. • Establish online/mobile application to record incidents/ impacts e.g. of pests and disease. • Establish a link to scheduled monuments and listed buildings at risk monitoring work.	• Targeted monitoring programme and condition data. • Best-practice guidance document/technical notes for monitoring assets at risk drawing on case studies.	• Improved understanding of the threats for the historic environment from a changing climate. • Provision of data for historic assets to assist the development of management strategies and prioritisation.
3. Research priorities			
3.1	Improve understanding of the interacting and cascading relationships, and cumulative impacts of climate risk factors. For example: • Building condition, location and socio-economic factors. • Changing land use and redundancy of agricultural buildings resulting in a cumulative loss of historic landscape features and changed settings. • Increases in invasive species that may impact on historic assets. • Acidification of seawater and increase in marine species which pose potential threats to wrecks/timber structures in marine conditions. • Measures to address chronic and acute pollution from historic mining.	• Reports and recommendations.	• Adaptive actions take inter-relationships and cumulative impacts into account, thereby minimising the potential for maladaptation, leading to improved management of historic assets and the creation of best-practice guidance.

	Description of the action	Output(s) from the action	Broad outcome/impact
3. Research priorities (Continued)			
	• Risks to building fabric from increased humidity, moisture, wind and driving rain, and the knock-on impact on indoor air quality and the health of building occupants. • Cumulative impact of successive extreme weather events on historic assets. • The frequency, range and potential regional variations of extreme weather events and their impact on the historic environment.		
3.2	Research to improve knowledge of past and present climate change impacts on historic assets e.g. decay/erosion/accretion.	• Research results, case studies and recommendations.	• Increased understanding of stages, timescales and outcomes leading to improved management and adaptation interventions to build resilience.
3.3	Improve understanding of the positive and negative effects of a longer growing season on the maintenance and management of the historic environment.	• Report and recommendations.	• Improved long-term adaptation and maintenance programmes.
3.4	Work with UKCP18 projections to identify opportunities for the historic environment and the economy e.g. planting of woodland and forestry; establishment of new industries relating to adaptation; changing leisure opportunities; increased use of UK coastal resorts.	• Identification of opportunities.	• A combined beneficial response to adaptation will encourage uptake and identification of new opportunities, including tourism investment.

Capacity: Develop the methodologies, tools and guidance to work with others and build adaptive capacity			
	Description of the action	Output(s) from the action	Broad outcome/impact
4. Dissemination and promotion			
4.1	Creation of a steering group to oversee the delivery of the HEG SAP and to monitor and review progress. The steering group will establish and coordinate working/subgroups as necessary.	• Steering group formed from representatives within Wales.	• The provision of a strategic framework through which the action plan is delivered.
4.2	Creation of a dedicated (full-time equivalent) Climate Change Manager post for the historic environment sector in Wales.	• Climate Change Manager in post.	• Direct action to help steer and guide the delivery of the HEG SAP and to play a central role in raising the profile of the climate change work across the historic environment sector in Wales.

	Description of the action	Output(s) from the action	Broad outcome/impact
5. Collaborative working			
5.1	The steering group to coordinate and encourage stakeholder engagement and promote partnership working to ensure efficient use of resources across sectors.	• Cross-sector partnerships and coordinated working will ensure resources are targeted effectively and efficiently.	• Effective delivery of the HEG SAP actions. • Raised awareness of the historic environment across the wider sector which will help prevent secondary damage and maladaptation to the historic environment. • Improved cross-sector working.
5.2	The steering group/working group to work with officials across Wales to embed the HEG SAP in national and local government policy statements, plans and codes.	• The historic environment will feature in the Welsh Government Climate Change Adaptation Plan for Wales. • The HEG SAP considerations will be linked and noted in, for example: – Shoreline Management Plans. – Relevant Planning Policy Wales supplements.	• Help prevent secondary damage and maladaptation to the historic environment.
5.3	Provide, promote and maintain a publicly available case study resource to illustrate climate change risks and impacts affecting the historic environment and examples of adaptation. All should be able to contribute to this resource.	• Case study resource.	• Raised awareness of the challenges posed by climate change and adaptation on the historic environment. • Demonstration of a range of practices and evidence of direct action.
6. Training and guidance			
6.1	Identify and support the training of historic environment practitioners specialising in the impacts of climate change and adaptation of the historic environment.	• Trained climate change historic environment practitioners.	• Raising standards to embed climate change considerations in the historic environment.
6.2	Climate change historic environment practitioners to provide training and support within and across sectors in the impacts of climate change and adaptation of the historic environment. For example: • Produce an e-learning module on the historic environment and climate change. • Organise slots at meetings, training events and workshops with other sectors.	• Planners and developers can advise authoritatively through pre-application advice e.g. on the design and implementation of adaptation proposals. • Grant officers can ensure changes and adaptation actions are sensitive to the historic environment. • Owners can identify and implement management and adaptation opportunities. • Community groups established to develop programmes to identify, monitor and record historic assets at risk.	• Raised standards to embed climate change considerations in the historic environment. • Improved cross-sector working, knowledge and understanding, decision-making and the quality of adaptation actions.

	Description of the action	Output(s) from the action	Broad outcome/impact
6. Training and guidance (Continued)			
6.3	Work collaboratively across sectors to develop and disseminate joint guidance/ advisory notes that increase the knowledge, understanding and resilience of the historic environment to climate change.	• Guidance/advisory notes produced and promoted. • Inclusion of climate change adaptation into all aspects of heritage management. • Heritage management and business plans with climate change adaptation embedded. • Management practices undertaken that showcase climate change adaptation.	• Improved cross-sector working, knowledge and understanding, decision-making and the quality of adaptation actions. • Prevention of secondary damage and maladaptation to the historic environment. • Improved management of the historic environment. • A well-managed and appropriate programme of adaptation measures.

Resilience: Increase resilience of the historic environment by implementing actions to respond and adapt to the risks			
	Description of the action	Output(s) from the action	Broad outcome/impact
7. Taking action			
7.1	Prepare and implement emergency/adaptation plans (utilising the principles and methods developed for conservation management plans) for vulnerable areas or sites as identified in 2.1 and 2.2. Plans to include multiple work streams if several agencies have identified the need for adaptation measures.	• Identification of significance, threat, vulnerability and adaptive action. • Partnership working with all agencies.	• The prioritisation and effective management of resources.
7.2	Undertake programme of landscape and urban characterisation to inform management of change in both rural and urban areas.	• Produce characterisation reports for areas at risk, and feed results into conservation management plans.	• Improved conservation and management of change.
7.3	Prioritised work programmes relating to historic assets at risk such as those identified through 7.1, spatial mapping work (2.1), baseline monitoring (2.2) and through other local and national adaptation plans e.g. shoreline management plans. Where possible to be preceded by a management plan. Direct actions could range from survey, record and monitoring through to maintenance and conservation measures, erosion control or moving significant vulnerable assets to a place of safety.	• Work programmes underway. • Improved protection and preservation of historic assets. • Improved management of historic assets.	• Mitigation and improved resilience of the historic environment. • Acceptance of inevitable change. • Partnership working and cross sector coordinated response.

	Description of the action	Output(s) from the action	Broad outcome/impact
7. Taking action (Continued)			
7.4	Establish stakeholder/community groups able to monitor assets and respond to significant events such as wild fires and storms to maximise the potential for the discovery of new historic assets and the recording and monitoring of them.	• Stakeholder/community groups established. • Monitoring regimes in place.	• Improved knowledge, management and resilience of the historic environment. • Raised awareness and appreciation of the historic environment.
7.5	Encourage and implement new planting regimes where trees and hedgerows form a key component of the historic environment to reduce the impact of the spread of disease and increased storminess.	• New planting regimes that are responsive to plant health trends and are of suitable provenance. • The preservation of traditional field boundaries.	• Reduced impact of the spread of diseases and storms. • Improved management and resilience of trees in the historic environment. • Retention and survival of historic character and integrity.

7. Conclusions and next steps ¬

The Welsh Government has declared a climate emergency and is committed to reducing greenhouse gas emissions. The impacts of climate change will be felt in Wales for decades if not centuries to come. Tackling the impacts of climate change will therefore require both mitigation and adaptation. However, adaptation has received far less attention than it deserves. As a result, public policy in this area is less well developed.

To address this imbalance and raise awareness of the need to improve our resilience more widely, good governance, strong leadership and expertise will be required, together with the allocation of sufficient resources, both human and financial.

Whilst this sector adaptation plan sets out the risks and opportunities facing the historic environment and is intended to provide a framework for action, it will gain little or no traction without the commitment and action of stakeholders, including the Welsh Ministers, senior decision-makers, asset managers and policy makers.

It is clear from the risk assessment and case studies that the potential impacts of climate change on the historic environment will be many and varied. To address the impacts, the actions identified in this plan have been organised around three objectives: increasing our knowledge, increasing our capacity and building our resilience.

This plan represents the first two stages of the adaptation cycle — starting and investigating (see Figure 6). The next step will be the planning stage. During 2020–21 this will include:

- **dissemination and publicity**, including development of a communications strategy to ensure engagement with the wider climate adaptation community, emphasising the cross-cutting nature of the historic environment
- **engagement** with politicians and senior decision-makers to secure resources and practical actions
- **developing new and existing partnerships** by building on partnerships established during the development of the sector adaptation plan, including a conference event to bring stakeholders together
- **identifying leads and partners** across sectors to work collaboratively to agree priorities and timescales, and to implement the actions identified. This may include the establishment of different working groups to tackle specific topics or actions.
- **continuing engagement** with the Welsh Government on the delivery of the commitments contained in *Prosperity for all: A climate conscious Wales*.[20]

The Historic Environment Group will also:

- **monitor and evaluate** progress against the actions in the sector adaptation plan and report to the Welsh Ministers every two years
- **review and update** the action table after five years
- **identify** the main historic environment adaptation priorities for the next Climate Change Risk Assessment (CCRA) Evidence Report.

20 *Prosperity for all: A climate conscious Wales*, Welsh Government, 2019 www.gov.wales/prosperity-all-climate-conscious-wales

Annex: Legislation and policy context ¬

Climate Change Act 2008 ¬

The Climate Change Act 2008[21] (the 2008 Act) commits the UK government and devolved administrations to reducing greenhouse gas emissions to achieve net zero by 2050 through setting legally binding carbon budgets and associated policies to ensure they are met. The Welsh Government published the first Low Carbon Delivery Plan for Wales *Prosperity for all: A low carbon Wales*[22] in March 2019 that sets out 100 policies and actions.

The 2008 Act requires an assessment of the risks and opportunities from climate change for the UK. The UK Climate Change Risk Assessment (2017)[23] assesses the risks from the current and predicted impacts of climate change, it includes a summary report for Wales. Updated UK climate projections were published in 2018[24] and will inform CCRA3.

The 2008 Act also requires the UK Government to produce a National Adaptation Programme that is for England and reserved matters, while devolved administrations produce their own programmes and policies. In Wales, Section 80 of the 2008 Act requires the Welsh Ministers to report on the Welsh Government's objectives, actions and priorities to deal with the impacts of climate change. The Welsh Government published the climate change adaptation plan for *Wales Prosperity for all: A cimate conscious Wales*[25] in December 2019 which set out 32 actions.

The Welsh Ministers have powers to produce guidance for public bodies on assessing and adapting to the impacts of climate change and discretionary powers to require public bodies to produce reports on their assessment of the impacts of climate change and their adaptation proposals. The Welsh Government published 'Preparing for a Changing Climate' in 2013 for reporting authorities in Wales, but have not to date required public body reporting.

Well-being of Future Generations (Wales) Act 2015[26] ¬

The Well-being of Future Generations (Wales) Act 2015 (the 2015 Act) is about improving the social, economic, environmental and cultural well-being of Wales. The 2015 Act puts in place a 'sustainable development principle' whereby listed public bodies must make sure that their decisions take into account the impact on people living in Wales now and in the future. Each listed public body must set, publish and report on their well-being objectives linked to all of the seven well-being goals.

The 2015 Act also deals with the reduction in greenhouse gas emissions and climate change adaptation. When preparing assessments of local well-being, public services boards must take into account the Future Trends Report,[27] which identifies the key social, environmental and cultural trends that could affect Wales in the future, and the most recent UK CCRA. The 2015 Act also sets up the post of Future Generations Commissioner, which includes a duty to provide advice or assistance to a public body, including on climate change.

21 UK Climate Change Act 2008 www.legislation.gov.uk/ukpga/2008/27/contents

22 *Prosperity for all: A low carbon Wales*, Welsh Government, 2019 www.gov.wales/prosperity-all-low-carbon-wales

23 UK Climate Change Risk Assessment 2017 Evidence Report www.theccc.org.uk/tackling-climate-change/preparing-for-climate-change/uk-climate-change-risk-assessment-2017/

24 UK Climate Projections (UKCP18), Met Office www.metoffice.gov.uk/research/approach/collaboration/ukcp/index

25 *Prosperity for all: A cimate conscious Wales*, Welsh Government, 2019 www.gov.wales/prosperity-all-climate-conscious-wales

26 Well-being of Future Generations (Wales) Act 2015 www.legislation.gov.uk/anaw/2015/2/contents/enacted

27 Future Trends Report www.gov.wales/statistics-and-research/future-trends/?lang=en

Environment (Wales) Act 2016[28] ¬

The Environment (Wales) Act 2016 (the 2016 Act) provides a framework to manage Wales's natural resources sustainably and collaboratively. Of particular relevance for climate adaptation are Parts 1, 2 and 7. Part 1 of the 2016 Act focuses on maintaining and enhancing the resilience of ecosystems through the sustainable management of natural resources (SMNR), recognising their benefits to well-being and their ability to adapt to climate change. Part 2 of the 2016 Act sets the emission reduction targets to 2050 and five-yearly carbon budgets and Part 7 establishes the Flood and Coastal Erosion Committee; their advice includes the risks and benefits of flood and coastal erosion risk management in Wales.

The Welsh Government's Natural Resources Policy (NRP)[29] sets out the key priorities, risks and opportunities for natural resource management, including what should be done in relation to climate change.

The state of natural resources report (SoNaRR)[30] assesses the extent to which natural resources in Wales are being sustainably managed and recommends a proactive approach to building resilience. Resilient ecosystems are more able to respond to pressures such as climate change.

The 2016 Act requires Natural Resources Wales (NRW) to produce area statements. Place-based area statements will consider the evidence from SoNaRR to help implement the NRP; they also form an evidence base for public service boards and local development plans.

Historic environment and planning policy ¬

The Welsh Government's *Planning Policy Wales*[31] sets out national land-use planning policies. Chapter 6 of *Planning Policy Wales*, Distinctive and Natural Places, features the historic environment and climate change is integrated throughout the document. This is supplemented by *Technical Advice Note 24: The Historic Environment*.[32] Together, they recognise that the planning system must take into account the Welsh Government's objectives to protect, conserve, promote and enhance the historic environment as a resource for the general well-being of present and future generations.

The underlying philosophy of conservation is set out in Cadw's *Conservation Principles for the Sustainable Management of the Historic Environment in Wales*.[33] This makes it clear that every conservation decision should be based on an understanding of its likely impact on the special qualities that contribute to the significance of historic assets. Cadw has also produced best-practice guidance for different types of historic asset which carries weight in the planning system.[34]

Prosperity for all: A climate conscious Wales ¬

The Welsh Government has closely supported the UK Committee on Climate Change and the UK Government in developing the latest Climate Change Risk Assessment (CCRA) and in doing so, has endorsed the 56 risks detailed in the supporting evidence report by the committee.

28 Environment (Wales) Act 2016 www.legislation.gov.uk/anaw/2016/3/contents/enacted

29 Natural Resources Policy www.gov.wales/natural-resources-policy

30 State of Natural Resources Report www.naturalresources.wales/evidence-and-data/research-and-reports/the-state-of-natural-resources-report-assessment-of-the-sustainable-management-of-natural-resources/?lang=en

31 *Planning Policy Wales*, Welsh Government www.gov.wales/planning-policy-wales

32 *Technical Advice Note 24: The Historic Environment*, Welsh Government, 2017 www.gov.wales/technical-advice-note-tan-24-historic-environment

33 *Conservation Principles for the Sustainable Management of the Historic Environment in Wales*, Cadw, Welsh Assembly Government, 2011 www.cadw.gov.wales/sites/default/files/2019-05/Conservation_Principles_EN_0.pdf

34 For Cadw's best-practice guidance, see www.cadw.gov.wales/advice-support/

The 2019 climate change adaptation plan for Wales, *Prosperity for all: A climate conscious Wales*,[35] has been developed to respond to these risks, focusing on those identified as 'more urgent'. Through it, the Welsh Government seeks to influence its partners in Wales to take action to raise awareness of climate adaptation and share knowledge and best practice. The plan also recognises the need for cross-sector working.

The technical annex sets out the Welsh Government's strategic approach and the actions that the delivery partners are committed to delivering over the five-year plan period. The annex brings purpose to the plan against a strong moral and legislative basis. Separate chapters then cover specific actions for nature and the rural economy; coasts and seas; health; homes and places; the historic environment; business, and infrastructure and transport.

The chapter on caring for the historic environment includes four overarching actions that are developed further in the Historic Environment and Climate Change in Wales Sector Adaptation Plan:

HE1 Complete and publish the Historic Environment and Climate Change Sector Adaptation Plan.

HE2 Improve understanding of the threats and opportunities for the historic environment from a changing climate.

HE3 Develop the methodologies, tools and guidance needed to build adaptive capacity.

HE4 Increase resilience of the historic environment by implementing actions to respond and adapt to the risks.

35 *Prosperity for all: A climate conscious Wales*, Welsh Government, 2019 www.gov.wales/prosperity-all-climate-conscious-wales