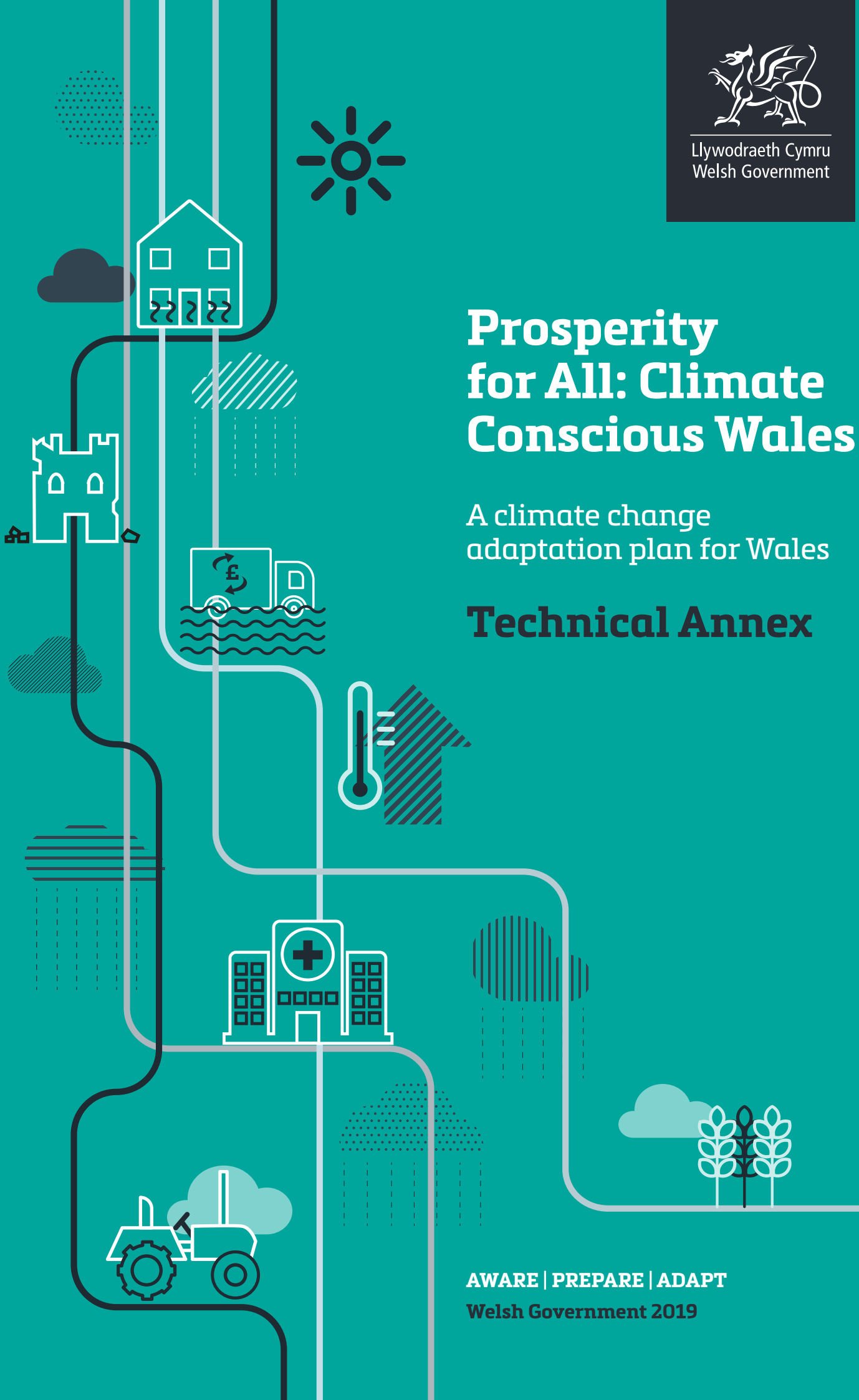

Llywodraeth Cymru
Welsh Government

Prosperity for All: Climate Conscious Wales

A climate change adaptation plan for Wales

Technical Annex

AWARE | PREPARE | ADAPT

Welsh Government 2019

Contents

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

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Part 1:
The Framework

Introduction

Significant research has been undertaken across the world and evidence shows very strongly that man-made greenhouse gas (GHG) emissions since the Industrial Revolution are leading to global warming, and that this warming is resulting in a change to our global climate. In April 2019, the Welsh Government announced a national climate emergency to accelerate the rate of progress and to instigate further action.

For many years now we have understood climate change as a large-scale, long-term shift in the planet's weather patterns and average temperatures – the latest models show that Wales can expect to see significant impacts from climate change by the year 2080[1]. Nevertheless, carbon dioxide emissions since the Industrial Revolution have increased by over 40% to levels that are unprecedented in at least 800,000 years[2]. This has caused warming throughout the climate system, and multiple indicators show evidence that our climate is already changing[3]; the oceans have warmed, the volume of snow and ice has diminished and, as a result, sea levels have already begun to rise.

The Welsh Government is committed to mitigating climate change through a programme of decarbonisation, but we also need to make sure we are resilient and ready to adapt to the impacts of climate change as a result of past, current and future global emissions. Climate change adaptation is a response to global warming which seeks to reduce the vulnerability of our environment, economy and society to offset the effects of any adverse impacts.

Our first *Climate Change Adaptation Delivery Plan* sits within our adaptation framework, detailed in chapter 15 of the Climate Change Strategy for Wales[4]. Published in 2010, it laid the foundations for a significant step towards our well-being goal of a resilient Wales. Since 2010, our achievements have included the publication and implementation of strategies to address flood and coastal erosion risk management, completion of impact assessments to understand the effects of climate change in the historic environment, and the implementation of a heat-wave plan for Wales. However, as our knowledge of the risks from climate change has grown, we recognise that we need to do more.

The Welsh Government has closely supported the UK Government in developing the latest Climate Change Risk Assessment (CCRA) and in doing so, endorsed the 56 risks detailed in the UK Committee on Climate Change's supporting evidence report. The new climate change adaptation plan for Wales has been developed to respond to the risks in the CCRA, focusing on those risks identified as high priority by answering the need for more action, or research, where necessary.

Climate Change in Wales

The impacts from climate change

The UK Climate Projections (UKCP18)[5] are the fourth generation of UK climate change scenarios, describing how the climate of the UK might change during the 21st Century. UKCP18 is a climate analysis tool that forms part of the Met Office Hadley Centre Climate Programme which is supported by the Department of Business, Energy and Industrial Strategy (BEIS) and the Department for Environment, Food and Rural Affairs (Defra). The projections give information on current and future climate change for the England, Wales, Northern Ireland, Scotland, the Isle of Man, Jersey, Guernsey and an area of sea around the UK.

Figure 1 – Climate change projections by 2050 and by 2080 for Wales[6]

By 2050...		By 2080...
Summer average temperatures in Wales are projected to increase by **1.34°C**		**Summer average temperatures in Wales** are projected to increase by **3.03°C**
Winter precipitation in Wales is projected to increase by **⬆ 5%**		**Winter precipitation in Wales** is projected to increase by **⬆ 9%**
Summer precipitation in Wales is projected to decrease by **⬇16%**		**Summer precipitation in Wales** is projected to decrease by **⬇ 23%**
Sea levels are predicted to rise across the country*, For example in **North Wales (Llandudno)**, by **⬆ 19cm** **Mid Wales (Aberystwyth)**, by **⬆ 22cm** **South Wales (Cardiff)**, by **⬆ 24cm**		**Sea levels** are predicted to rise across the country*, For example in **North Wales (Llandudno)**, by **⬆ 34cm** **Mid Wales (Aberystwyth)**, by **⬆ 38cm** **South Wales (Cardiff)**, by **⬆ 42cm**

All projections are taken from a 1981-2000 baseline, at the 50th percentile, meaning they represent an outcome which is as likely as it is unlikely to occur.
*SLR projections are taken from RCP 4.5 (medium-high) emissions scenario. All other projections from RCP 6.0 (high) emissions scenario. Read below for further description.

The UKCP18 projections provide a probabilistic view on climate change for different future GHG emissions scenarios (high, medium and low), as developed by the Intergovernmental Panel on Climate Change (IPCC)[7]. Low emissions scenarios, which would require significant mitigation actions, avoid the worst of the predicted consequences. However due to historical emissions, we are unavoidably locked into some aspects of global climate change which will require adaptation measures to be adopted across all sectors in Wales. Note that sea level rise data is not available at time of writing for the high emissions (RCP 6.0) scenario.

It is important to note that UKCP18 does not capture all possible future outcomes. The 'probabilistic projections' interpreted from the modelling aim to provide the primary tool for assessments of the ranges of uncertainties in UKCP18. It is necessary to emphasise, therefore, there is no complete certainty as to what climate change may indeed bring.

Climate risks in Wales

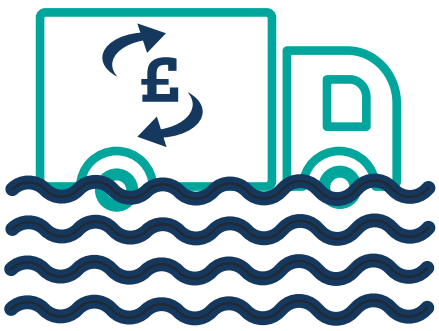
More rain, warmer temperatures, rising sea levels, stronger winds and fiercer storms. These impacts will have an effect on all sectors across Wales in different ways. Before we begin to adapt to the impacts, it is vital we understand where these impacts will be felt the most, and understand the risks that we need to mitigate.

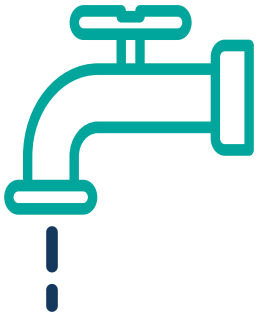
In order to assess the risks, the UK Committee on Climate Change (UKCCC) has looked at current policies in place and reviewed these in light of the anticipated impacts from climate change at present, and in the future. Their resulting Evidence Report Summary for Wales[8] (CCRAER) presents a national assessment of 56 risks and opportunities arising from climate change impacting on Wales from now until the end of this century. The UKCCC's report organises the risks into five sectors in Wales, and prioritises them into four categories. Those with highest priority and stated as 'more urgent' are categorised as 'more action needed' or 'research priority'. The remaining low priority, less urgent risks are categorised as 'sustain current action' or 'watching brief'.

Table 1: Summary of climate change risks to Wales (adapyed from Climate Change Risk Assessment Evidence Report Wales Summary, UKCCC)

Risks to infrastructure (from all sources of flooding)	**More Action needed**
Risks to public water supplies from drought and low flows	
Some land management practices exacerbating flood risk	
Risks to ecosystems and agriculture businesses from changes in climatic conditions	
Risks to communities from all sources of flooding and sea level rise	**Research Priorities**
Risks to infrastructure, businesses and buildings from high river flows, erosion and extreme weather	
Risks and opportunities from changes in agriculture and forestry productivity	
Risks to people's health and well-being and associated service delivery from high temperatures, flooding and extreme weather	

A complete list of the more urgent risks is available in Appendix 1, however, the highest priority risks to Wales are briefly summarised in Table 1 above. This climate change adaptation plan for Wales responds to the risks from the CCRA and will focus on those described as 'more urgent' by the UKCCC.





Adaptation and decarbonisation

While it is essential we prepare for the impacts of climate change, we must continue to do what we can to limit the cause. This means reducing and sequestering (in other words long-term storage of carbon dioxide or other forms of carbon to either mitigate or defer global warming) our emissions of greenhouse gases such as carbon dioxide.

The Environment (Wales) Act 2016 places a duty on Welsh Ministers to ensure that by 2050, net emissions are at least 80% lower than the baseline set in legislation (generally 1990). This will be achieved through the setting of interim targets for 2020, 2030 and 2040 and 5-yearly carbon budgets up until to 2050. We have set the 5-yearly carbon budgets for 2016-2020 and 2021-2025 (Climate Change (Carbon Budgets) (Wales) Regulations 2018):

- these budgets are: 23% lower than the baseline by 2020; and 33% lower than the baseline by 2025
- we intend to set the next carbon budget (i.e. 2026-2030) in due course
- we've set interim targets for these years (Climate Change (Interim Emissions Targets) (Wales) Regulations 2018)
- these set the maximum emissions at: 27% lower than the baseline for 2020; 45% lower than the baseline for 2030; and 67% lower than the baseline for 2040.

These are evidence of the WMs' objectives/future priorities in relation to emissions and the actions taken to deal with them (required under section 80(1)(a)-(c) CCA 2008).

More recently the Welsh Government has received updated advice from the UK Committee on Climate Change (UKCCC) in a report on achieving Net Zero[9]. The Welsh Government has accepted the advice to revise the target to 95% by 2050 and will be amending the legislation in due course to reflect the new targets and trajectory. In accepting the advice the Minister for Environment, Energy and Rural Affairs also stated the Government's ambition of going further and striving for net zero by 2050, whilst recognising the challenges outlined in the advice from the UKCCC.

The Environment (Wales) Act 2016 imposes a duty on the Welsh Ministers to prepare and publish a set of policies and proposals for meeting the carbon budget for each budgetary period. The Welsh Ministers are also required to publish a statement of progress after each budgetary period. The UKCCC will provide advice on the latest scientific evidence and report progress made against budget targets. A programme[i] has been established to implement the requirements of the Environment (Wales) Act 2016, which focuses on reducing future emissions.

Prosperity for All: A Climate Conscious Wales has been purposefully developed separately from the decarbonisation programme. This is to make sure its actions are clear and its progress is accountable. However, it is vital to recognise the connections and synergies between the two approaches to tackle climate change, since in many cases, the actions needed are of benefit to both. The Welsh Government is working very closely between the areas of adaptation and decarbonisation, both internally and with external stakeholders, to make sure both issues are considered.

There are some important examples of synergies between decarbonisation and adaptation in this plan. Deep-peat soil is a vital natural asset in terms of decarbonisation – it covers 4.3% of the total land area in Wales

i. https://gweddill.gov.wales/topics/environmentcountryside/climatechange/emissions/prosperity-for-all-a-low-carbon-wales/?skip=1&lang=en

and represent Wales' largest terrestrial store of carbon[10]. Peatlands in good condition sequester carbon dioxide from the atmosphere. However, the Climate Change Risk Assessment provides evidence that drought conditions from climate change are likely going to damage these peatlands, leading to a reversal of this process and emitting carbon dioxide. Climate change adaptation is essential here to ensure peatlands are kept wet and sustainable as carbon sinks and stores.

Another example can be found in the built environment. We need to make sure our homes and buildings are efficient to lower the amount of energy used to warm our homes, and lift families out of fuel poverty.

There are a number of means to achieve this. Part L of the Building Regulations puts in place the protocols around energy efficiency which are followed by those who design and build homes. We are looking at these regulations to try and make our homes more energy efficient and lower our carbon footprints. However, we also need to think about the future projections of our climate, in conjunction with improving energy efficiency, to ensure we do not exacerbate the issue of summertime overheating in our homes, impacting our health. We will therefore make sure the need to adapt to climate change is considered in the building regulations review in order to keep occupants cool in hot weather.

Climate Change Adaptation and the law: What it means for Wales

The Climate Change Act 2008

The Climate Change Adaptation Plan for Wales is supported by provisions in a piece of UK legislation in the form of the Climate Change Act 2008 (CCA), which addresses, among other things, the impact of, and adaptation to, climate change.

The risks summarised in Table 1 above were extracted from the latest Climate Change Risk Assessment Evidence Report, which was developed to inform the UK Government's latest Climate Change Risk Assessment (CCRA). The CCA requires the UK Government to publish a CCRA to assess the risks to the UK from the current and predicted impacts of climate change. The CCRA includes national summaries for each country, including Wales in the UK. The Act establishes a 5-yearly cycle for review and updating of the CCRA.

There are a number of requirements, with regards to climate change adaptation, which are placed upon Welsh Ministers within the CCA. Section 80 of the Act places requirements on Welsh Ministers to produce a report from time to time on the Welsh Government's objectives, actions and future priorities regarding the impacts of climate change.

The CCA also provides Welsh Ministers with 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 current and predicted impacts of climate change; their proposals for adapting to these impacts in the future; and their assessment of their progress in implementing any previous adaptation policies.

Over the lifetime of this plan period Welsh Government will seek to maximise

reporting arrangements, as outlined in existing legislation, such as the Well-being of Future Generations (Wales) Act 2015 to ensure that effective climate change adaptation plans are made by public bodies in Wales. Should existing arrangements prove unsuccessful in demonstrating plans for adaptation in Wales, Welsh Government will re-consider invoking the reporting power by holding a consultation with public bodies in Wales.

The Environment (Wales) Act 2016

The The Environment (Wales) Act 2016 provides a framework to manage Wales' natural resources in a proactive, sustainable and collaborative way and aims to position Wales as a low carbon and green economy, ready to adapt to the impacts of climate change.

There are 7 parts to the Act. Part 2 sets out the framework for emission reductions targets for Wales to decarbonise (described in the decarbonisation paragraphs above), while parts 3 to 6 set out laws with regards to carrier bag charges, waste, fisheries and marine licensing. However, parts 1 and 7 are of key interest for climate change adaptation.

Part 7 establishes the Flood & Coastal Erosion Committee and clarifies the law for other environmental regulatory regimes including flood risk management and land drainage. The Committee has a wide advisory role including advice on the wider risks and benefits of flood and coastal erosion risk management in Wales across all sources of flooding i.e. flooding from surface water, main rivers, coastal flooding and coastal erosion.

Sustainable Management of Natural Resources (SMNR)

The objective of Part 1 of the Environment (Wales) Act 2016 is to maintain and enhance the resilience of ecosystems so that they support the benefits to our well-being, including the ability to adapt to climate change.

We have learnt from the experiences of our international partners and are using international best practice drawing from the UN Convention on Biological Diversity ecosystem approach, to help Wales lead the way on Sustainable Development. Healthy and resilient ecosystems are also more able to deal with increased demands and pressures on them including from climate change.

To achieve all this, the Act provides for the preparation of a State of Natural Resources Report[ii] (SoNaRR) which is the national evidence base for SMNR and also provides an assessment of the extent to which SMNR is being achieved.

Natural Resources Policy for Wales

The Natural Resources Policy[iii] (NRP) draws on the evidence in SoNaRR to set out national priorities for managing Wales' natural resources sustainably, including what should be done in relation to climate change. The priorities support the delivery of all the well-being goals, and so support the wide social and economic issues that need to be tackled. The national priorities are:

- delivering nature-based solutions
- increasing renewable energy and resource efficiency
- taking a place-based approach.

Nature-based solutions are defined by the International Union for Conservation of Nature (IUCN) as "actions to protect, sustainably manage, and restore natural or modified ecosystems that address societal challenges

ii. https://naturalresources.wales/evidence-and-data/research-and-reports/the-state-of-natural-resources-report-assessment-of-the-sustainable-management-of-natural-resources/?lang=en

iii. https://gov.wales/natural-resources-policy

effectively and adaptively, simultaneously providing human well-being and biodiversity benefits''. They include approaches to improve infrastructure, support climate change adaptation and mitigation and improve land and water management. The Natural Resources Policy sets out the following areas for nature based solutions:

- increasing green infrastructure in and around urban areas
- coastal zone management and adaptation
- increased canopy cover and well-located woodland for greatest ecosystem service value
- maintaining, enhancing and restoring floodplains and hydrogeological systems to reduce flood risk and improve water quality and supply
- restoration of our uplands and managing them for biodiversity, carbon, water, flood risk and recreational benefits.
- support the development of resilient ecological networks.

These priorities support many of the high priority categories identified for more action in this plan including: supporting risks to infrastructure from flooding, protecting public water supplies, mitigating land management practices which exacerbate flood risk, reducing the risk to ecosystems and agricultural practices and reducing risks to soil, agriculture and wildlife. Our 'living infrastructure' forms part of the critical national infrastructure requirements for our businesses, communities and public services in the same way as our 'built' solutions.

The priority 'taking a place based approach' supports the need for capacity building for climate change adaptation within the community. Taking specific action for biodiversity, for example improving the management of our protected sites as part of resilient ecological networks, will enable habitats and species to thrive and expand, providing ecosystem services well beyond the site boundaries.

Delivering the priorities in the Natural Resources Policy

Everyone has a role to play in delivering the priorities in the Natural Resources Policy. The approach Welsh Government is taking to delivery is to align policies to the delivery of the national priorities.

The Environment (Wales) Act 2016 also requires Natural Resources Wales (NRW) prepare, publish and review Area Statements. Each area of Wales must be included within at least one Area Statement. Area Statements will consider the evidence from the State of Natural Resources Report to help implement the priorities, risks and opportunities identified in the Natural Resources Policy at the local level. This is to ensure the Natural Resources Policy takes a place based approach and that its impact is maximised. Area statements will also provide a local evidence base for public service boards and local development plans.

The Well-being of Future Generations (Wales) Act 2015

The key purpose of the Well-being of Future Generations (Wales) Act 2015 is to improve the social, economic, environmental and cultural well-being of Wales, protecting our country's assets for the future. Through five ways of working, the Act makes public bodies (as listed in the Act) think more about the long-term, work better with people, communities and each other, look to prevent problems and take a more joined-up approach.

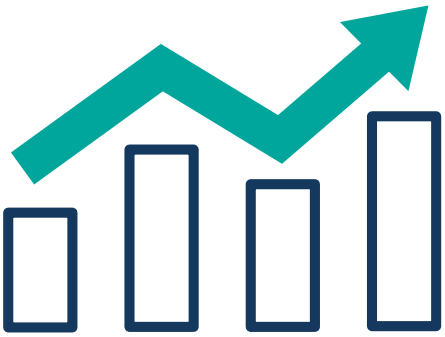
There are a number of parts to the Act, all of which are important to climate change adaptation. This is because protecting our country for future generations requires adapting to climate change. Several aspects of the Act are, however, of particular importance.

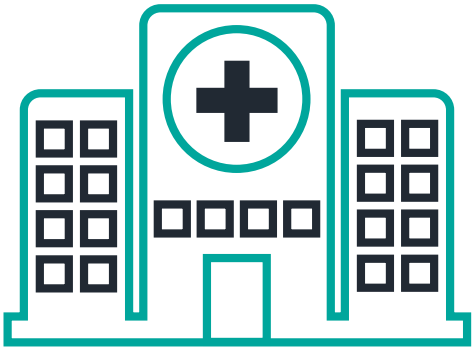
Future Trends Report

It is important that we understand the challenges that we will be facing, and have a clear picture of where we are heading. To do this, within the twelve months after an Assembly election, Ministers must publish a 'Future Trends Report' containing predictions of likely future trends in social, economic, environmental and cultural well-being of Wales. In preparing the report, Welsh Ministers must take account of the United Nations' sustainable development goals and the impact of climate change on Wales. The latest report[11] was produced in 2017 and includes a section on the risks of climate change, making reference to the latest Climate Change Risk Assessment. The report helps inform Welsh Ministers' decisions on policy to ensure sustainable development into the future.

Public Service Boards

The Act also establishes Public Service Boards (PSBs) for each Local Authority in Wales, made up from representatives of public bodies including Local Authorities, Health Boards, Fire and Rescue and Natural Resources Wales. Each PSB must improve the economic, social, environmental and cultural well-being of its area by working to achieve the well-being goals (set out below). To do this, each PSB must develop a Well-being Plan, and each plan must be informed by a Well-being Assessment. The Act requires PSBs to take the latest Climate Change Risk Assessment into account when developing their Well-being Assessments.





Well-being Goals

The Well-being of Future Generations (Wales) Act was the first piece of legislation in the world to link with the United Nations' Sustainable Development Goals by putting in place seven well-being goals for Wales to make sure we are all working towards the same vision. All public bodies have a responsibility to contribute towards reaching these goals. All seven are important when thinking about the need to adapt to the impacts of climate change and examples of how we intend to do this are set out below.

Figure 2. The Well-being Goals of the Well-being of Future Generations (Wales) Act 2015

Prosperity for All: A Climate Conscious Wales goes to great lengths to reach these goals. Each of the actions below, in Part 2 of this annex have been carefully considered to ensure Wales is resilient to the impacts expected from climate change in areas such as health, economy, communities and homes.

Outlined below is a summary of how the actions contribute to the seven goals, by highlighting some of our actions moving forward.

Some of the well-being goals are particularly important in regards to climate change. The Act defines '**a resilient Wales**' as:

"A nation which maintains and enhances a biodiverse natural environment with healthy functioning ecosystems that support social, economic and ecological resilience and the capacity to adapt to change (for example climate change)."

The actions in the plan will help to build resilient ecological networks and nature based solutions to ensure our ecosystems are healthy and functioning to maximise their resilience.

Our actions will help Wales become an innovative, productive and low carbon **prosperous Wales** which recognises the limits of the global environment. In our rural economy, for example, we are committing to work with the Agriculture Industry Climate Change Forum to develop a Sustainable Brand Values Programme, supporting adaptation in agriculture. In support of businesses in other sectors, Welsh Government will review its Climate Change Adaptation Business Tool, currently targeted towards the tourism sector, to give advice on adaptation resources and best practice. We are also looking to improve the resilience of our infrastructure in this plan, making sure our staff are able to reach their places of work through schemes such as Network Rail's Vegetation Management Capability Development Programme, to manage line-side growth and reduce incidences of weather-related cancellations.

We will also be supporting businesses through Welsh Government's Business Wales website by raising awareness of issues such as overheating in the workplace. Doing this also contributes to the goal of a **healthier Wales**. An entire section of this plan is dedicated to staying healthy and includes actions to answer the health-related research needs highlighted in the UKCCC's Climate Change Risk Assessment. Under this plan for instance, we will be increasing our understanding of the risk of extreme weather to the delivery of health and social services, revising Public Health Wales guidance related to the impacts of climate change, and improving monitoring at our ports and airports of new diseases carried by vectors such as mosquitos.

It is an unfortunate truth that those who experience inequality are more likely to be impacted by the effects of climate change. The United Nations[12] highlights that inequality results in less resources for disadvantaged groups to undertake coping and recovery measures from various impacts from climate change. Our plan, therefore, also includes some actions to make a **more equal Wales**. The UKCCC explain that while there are potential health benefits from warmer winters in Wales, more action is needed to manage current risks to people from cold temperatures through addressing fuel poverty. In our plan, we have reiterated our target to ensure a further 25,000 homes benefit from the Warm Homes Programme by 2021 and to complete research to evaluate the impacts of the Nest and Arbed schemes on health outcomes by 2021.

We will also be working with a number of community led organisations to support those most in need to create a more equal Wales, contributing to the goal of a **Wales of cohesive communities**. There are specific actions in the plan to work with communities. We will help improve local environments through projects such as 'Renew Wales' which uses a mentoring approach to support community projects which might otherwise lack the knowledge needed to deliver successful projects. We are also supporting the Create-Your-Space programme which aims to reconnect local communities with local ecosystems, making them aware of local environmental issues in need of adaptation.

In many cases, working to support local communities in this way will contribute to retaining local culture. Our adaptation plan includes a chapter on the historic environment, recognising how this sector weaves through almost every other and demonstrating the importance of cross-sector working. Actions in this chapter will ensure a **Wales of vibrant culture and thriving Welsh Language** by preserving our heritage for future generations. The Historic Environment Sector Adaptation Plan, to be published in 2019, will include actions to preserve our heritage, mitigating the damage to historic assets from extreme weather, for example. Our work with communities and schools will also provide opportunities to promote the Welsh Language.

We have detailed a number of strategic actions that cut across all parts of this climate change adaptation plan, which include our efforts in creating a **globally responsible Wales**. Wales participates in a number of international groups to promote, share and learn best practice for adaptation to climate change. This includes the Network of Regional Governments for Sustainable Development and the RegionsADAPT initiative. We also support other nations in taking steps to adapt through projects such as the Wales in Africa programme. The programme funds the 'Size of Wales' project which has already helped plant over 8 million trees in Mbale. More detail on this project and all others mentioned above is given in Part 2 of this plan below.

Approach to the plan

Objectives

To make our vision a reality, *Prosperity for All: A Climate Conscious Wales* contains actions to make sure we adapt to the impacts of climate change. These actions contribute to three core objectives which have been carefully chosen to ensure a multifaceted approach to mitigating the impacts.
The three objectives are knowledge, capacity and resilience. Listed below, they have been colour coded to help identify how the actions contribute.

Figure 3 – The three core objectives of this Climate Change Adaptation Plan for Wales

Knowledge	Capacity	Resilience
Increase our knowledge and understanding of the impacts, risks, opportunities and threats from climate change on all sectors in Wales in the short, medium and long term.	Develop the tools and processes needed to manage the risks and work with others to support and build adaptive capacity in social, environmental and economic circles.	Take direct action to adapt to the impacts early by reducing vulnerability, lessening the threats and taking advantage of the opportunities that will come from climate change.

Structure

The structure of our technical annex has been carefully designed to make clear what we are going to do over the next five years, in order to make Wales resilient to the impacts of climate change. The action chapters in part 2 below outline the 32 actions in seven sectors (and one strategic chapter) that we will complete over this period. Each chapter details a sector which was chosen to represent the more urgent risks as given in the UKCCC's evidence report. The structure of each chapter has been designed to give the reader enough information early on in order to understand our commitments in summary, before then going into more detailed narrative to explain how we intend to deliver them.

The start of each chapter briefly explains how each sector is affected by the multiple impacts of climate change. This is to help understand why the sector is important, why action is needed, and to understand the chapter in the context of the rest of our adaptation plan. Each chapter then includes a simple one-page outline of three key considerations – the 'urgent risks' for the chapter, the gaps in action we need to address and a short section on cross-sector working.

The 'urgent risks'

Our approach to the adaptation plan has been to focus on those risks given in the UK Climate Change Risk Assessment 2017 Evidence Report Summary for Wales, as 'more urgent'. The report states these are the risks identified as 'more action needed' or 'research priorities'. These risks are highlighted at the top of the one page summary.

In some cases, there are other risks from climate change for which the UK Committee on Climate Change have stated we should

'sustain current action'. Detail against these risks, has been included at the end of each chapter where appropriate. In addition, there are 10 risks within the UK Climate Change Risk Assessment 2017 Evidence Report Summary for Wales designated as 'watching brief'. Our approach to monitoring these risks is detailed as an action in its own right, under the strategic actions section in part 2 below.

The gaps

In coming to their conclusions on designating urgency scores to the risks in the CCRA, the UKCCC summarise each risk by suggesting the type of action needed. This provides an insight into the gaps in adaptation action in Wales and describes what could be done to rectify the gap. The middle section of the one page summary in each chapter summarises these gaps.

Cross-sector working

Each sector is not by any means discrete from any of the others. In many cases, actions within each sector will benefit others in multiple and significant ways. A short summary to explain the importance of cross-sector working is included here.

The actions

The actions under each chapter are summarised in action tables. Each action table is colour-coded to demonstrate which of the above three objectives the action supports, and paints a clear picture of what we are committing to achieve, by when and with whom. Each chapter then ends with detail about how we intend to carry out the many commitments. The actions in our plan are numbered with abbreviations relevant to each section (for example CCAPW-AN1, an abbreviation of 'climate change adaptation plan for Wales – Adaptive Nature'), and summarised in the appendices below. The appendices also maps out the risks from the CCRA Evidence Report and actions to which they relate, for ease of reference.

A 'living' plan

It is important to understand that adaptation in Wales will be a continual process – this plan will not be a single means to an end. We need to ensure the actions outlined in this plan continue to be appropriate and deliverable once the United Kingdom leaves the European Union. We have recognised this already with our *'Sustainable Farming and our Land*[13] and *Brexit our Land consultations*[iv]*'* consultation to develop a sustainable land management scheme post-EU, which recognises the need to adapt to the challenges of climate change (see 'adaptive nature and rural economy' below). We also understand that global knowledge with regards to climate change and adaptation is constantly improving, and that different risks and reasons to act may arise.

The next climate change risk assessment will be published by the UKCCC in June 2021. For these reasons, we will look to review and revise our implementation as we progress – adding new actions as the need becomes clear. There are a number of risks from climate change that we need to understand better in order to act. The actions listed in this technical annex are those we intend to begin now, working closely with organisations across the country.

iv https://gov.wales/written-statement-brexit-and-our-land-summary-responses-and-our-response

Each of the actions in this document has been considered with care, following a review of the risks and opportunities highlighted in the UK Government's latest Climate Change Risk Assessment, the associated Evidence Report published by the UK Committee on Climate Change, and in consultation with sector practitioners and expert organisations.

Monitoring & evaluation

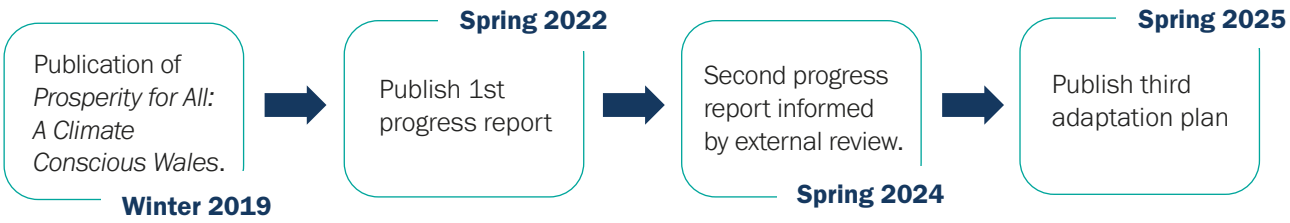
Monitoring and evaluating the progress of any plan of action is essential to measure progress, and a suitable monitoring and evaluation framework will therefore be developed alongside our plan.

The framework will put in place the means to develop a mechanism allowing for an understanding and monitoring of the progress made by Welsh Government and its stakeholders, in the implementation of specific actions below. The framework will also allow policy makers the possibility to evaluate long-term changes produced by the plan on relevant issues, to inform the development of any further, or future actions, and to help inform our next plan.

Our monitoring and evaluation framework makes clear the baselines and indicators for the actions as well as bring a level of accountability to the plan to measure our progress. In contrast to our previous adaptation plan, we will be reporting separately on our progress on decarbonisation (as required by sections 39 and 41 of the Environment (Wales) Act 2016) – this is to make sure there is clarity between the two subjects so that the evidence is not lost in the mix of the two.

Welsh Government will report progress every two years. The second progress report will also be informed by a review by the UK Committee on Climate Change. This is to make sure we are obtaining independent advice on progress to feed into the development of our third adaptation plan.

Figure 4 – Reporting timeline for monitoring and evaluation



Part 2:
The Actions

Our strategic approach

Adapting to the impacts of climate change requires a strategic approach. The way we communicate the impacts, the risks and the actions we are taking needs to be clear, concise and accessible. We also need to take a consistent approach to our research so as to ensure our actions are based on an understanding of change shared by all.

Our action plan includes a number of commitments to support adaptation efforts across all sectors. These ensure better communication and governance, as well as collaboration at a high level to develop the understanding needed to effectively adapt. By improving our approach to communication, we will be better placed to support sectors in finding resources to help them adapt. We will also work across the country with many stakeholders to fill knowledge gaps where needed, to make sure we have all the information we need before taking action.

The Welsh Government is also aware that more needs to be done internally to ensure the risks of climate change are considered in all its work. This section therefore also includes actions to address this and the way we integrate adaptation into business planning elsewhere.

Climate change does not respect borders and we understand very clearly the disproportionate ways in which climate change can affect developing countries which are less able to adapt. In many cases, the parts of our world which are most vulnerable are those which historically have emitted the least amount of the greenhouse gases which we understand have led to a changing climate. Similarly, this new adaptation plan presents a chance to improve the living conditions for the more vulnerable communities in Wales and to close the inequality gaps highlighted in the Equality and Human Right's Commission's *'Is Wales Fairer'* report. It is our responsibility to support these countries and vulnerable communities and our adaptation plan includes a number of collaborative actions with nations across the world.

The risks

As this section looks at our strategic actions, all risks from the CCRA are being considered here to some degree. For example, action ST3 below will include supporting the UKCCC in a number of research programmes to address gaps in understanding on water supply, human behaviour and the natural environment.

Our commitments

ST1 Knowledge	Review and update our approach to communication for climate change adaptation in Wales.

The Welsh Government is seeking to deliver a new communication programme by updating all online and offline adaptation content to raise the profile of adaptation and provide support on adaptation for key agencies.

Sub Actions	• Update and review climate change adaptation webpages at gov.wales • Review and update adaptation tools available on gov.wales • Increase communication through more online presence and other communication channels. • Develop and publish a children and young people's version of this adaptation plan. • Publish a Wales-level summary analysis of the UK Climate Projections 2018.
Timescale	2019
Outcome on climate risk	General public awareness of the risks of climate change will increase, as will public knowledge of what actions can be undertaken to adapt to these risks. People and organisations will have access to tools and guidance to be prepared for climate change, know what to do to manage risk and where to go to seek help.
Stakeholders	All sectors
Delivery partners	The Welsh Government

ST2 Capacity	Integrate the consideration of climate risks in all future policy and business planning within the Welsh Government and encourage the same in all other public bodies.

The Welsh Government is seeking to make sure climate adaptation is considered by civil servants, the Welsh Ministers and public bodies in the way that they operate.

Sub Actions	• Include climate change risk as a requirement in the Welsh Government's integrated impact assessment process. • Review and update the Welsh Government's adaptation statutory guidance. • Review the Welsh Government's position on the use of the Adaptation Reporting Power in section 67 of the Climate Change Act 2008, should it be necessary.
Timescale	2019
Outcome on climate risk	Climate risks will be considered more in material which is subject to assessments and therefore more likely to be managed.
Stakeholders	Public bodies Reporting authorities
Delivery partners	The Welsh Government

ST3 Capacity	Assess the risks and opportunities presented by climate change through active engagement in UK research programmes

The Welsh Government is seeking to make sure that research commissioned at an international, UK or Wales-level on climate risks reflects Wales' interests, and that Wales contributes to this research.

Sub Actions	• Collaboration with academia, research councils, NGOs, the UK Government and the devolved administrations to fill knowledge gaps on the risks and opportunities of climate change. • Support development of the 3rd UK Climate Change Risk Assessment. • Collaborate with the UK Committee on Climate Change to monitor those risks designated as 'watching brief'. • Collaborate with the *Environment Platform Wales*, launched in June 2019.
Outcome on climate risk	Fully understanding the impacts, risks and opportunities from climate change is essential to support climate adaptation across Wales and to make sure adaptation action does not make any situation worse.
Stakeholders	Academia and Universities The UK Government Devolved Administrations Non-governmental organisations Research councils UK Committee on Climate Change
Delivery partners	Academia and Universities The UK Government Non-governmental organisations Research councils UK Committee on Climate Change

ST4 Resilience	Support the international community to adapt to climate change at a global level.

The Welsh Government is seeking to show how the projects they support contribute to the global climate adaptation agenda.

Sub Actions	• Support projects to help other countries adapt to climate change where they are otherwise less able. • Continue collaboration with the international adaptation community to share adaptation best practice and knowledge of climate impacts and risk.
Outcome on climate risk	Knowledge sharing with international partners allows for improved understanding of effective adaptation practice. Supporting developing countries through adaptation projects reduces climate change risks elsewhere.
Stakeholders	The Welsh Government International third-sector organisations Regions4 Other nations
Delivery partners	The Welsh Government Size of Wales Keep Wales Tidy Plant!

Communication

Global knowledge of the impacts, risks and opportunities of climate change is constantly improving, so we need to ensure that the decisions we make, the support we offer and the advice we give is based upon the very latest knowledge. That means improving the way we communicate our adaptation work to ensure it is accessible, understandable and practical.

Following publication of *Prosperity for All: A Climate Conscious Wales*, the Welsh Government will overhaul its approach to communication around adaptation. This will include a complete review of webpages, and other forms of online presence to ensure everyone who needs it has access to the latest information in Wales. A children and young people's version of this plan will be developed to make sure our future generations are aware of the risks and actions needed, but also to encourage them to discuss these issues with their families.

Our 2010 Adaptation Delivery Plan led to the development of a number of online tools to support other organisations in adapting to climate change. As part of our communication overhaul, we will also bring these tools up to date with the latest information and look at new ways, such as social media, to reach out to organisations across the nation and help them adapt to climate risks. In addition, the Welsh Government will develop new e-learning tools to be shared among the public sector to help improve knowledge of climate risks in these areas. By continually reviewing the latest developments on adaptation, we will collect and share case studies of good adaptation practice to guide practitioners in their work.

Adaptation in Wales

The impacts of climate change in Wales are already being seen across many sectors and the heat wave of July 2018 raised questions of how prepared we are to deal with extreme weather situations. The latest Climate Change Risk Assessment makes clear the wide impacts of a changing climate and we therefore need to ensure that the risks and impacts are reviewed in all policy making from now on. Not only must we work to adapt, but we also need to ensure that none of our future decisions exacerbate the risks. The Welsh Government has now included consideration of climate change risks in the integrated impact assessment to embed adaptation into policy making in the future.

The Welsh Government will support private and public sector bodies, where possible, to achieve our vision of a resilient Wales. To do this, it will consider the need to review the current statutory adaptation guidance for public bodies and all other organisations to ensure it is as effective as it can be in encouraging and supporting other organisations in preparing adaptation plans. The Climate Change Act 2008 affords the Welsh Government a discretionary power, known as the Adaptation Reporting Power, to direct certain bodies ('reporting authorities') to report on their preparations for climate change. The Welsh Government consulted on the use of this power early in 2011 and decided not to invoke the power, because it was felt that there were enough reporting arrangements in place for public bodies and Welsh Government decided to give this more time to mature. In light of the risks highlighted in the Climate Change Risk Assessment, Welsh Government will continue to monitor how well adaptation is reflection in plans produced by public bodies. Should existing arrangements prove unsuccessful in demonstrating plans for adaptation in Wales, Welsh Government will re-consider invoking the reporting power by holding a consultation with public bodies in Wales.

Research and understanding

The UKCCC highlights 21 risks in its Climate Change Risk Assessment Evidence Report as 'Research Priorities' for Wales. As all the

risks highlighted in the report are cross-cutting, it is important to include a strategic action to ensure our efforts to address knowledge gaps are co-ordinated and consistent in nature. The Welsh Government has committed to addressing a number of research gaps separately in actions listed elsewhere in this document. Nevertheless, we have already begun to work with the UKCCC, the UK Government and research councils to answer cross- sector questions, such as how the risks from climate change interact. We will report on our research efforts periodically and use the resulting evidence to help develop further adaptation actions in the future. The research will also contribute to the third Climate Change Risk Assessment, due to be published in 2021.

The Welsh Government also commits to continued collaboration with the UK Committee on Climate Change to monitor the levels of risks across all sectors. Ten of the risks within the UK Climate Change Risk Assessment 2017 Evidence Report Summary for Wales have been designated as 'watching brief'. The UKCCC defines these risks as those which 'should be kept under review, with long-term monitoring of risk levels and adaptation activity so that further action can be taken if necessary'. The Welsh Government contributes to the funding of the Committee's Adaptation Sub-Committee, and will continue to work with them to ensure the long term monitoring of these risks in the development of future Climate Change Risk Assessments.

Case Study

The Welsh Government is collaborating with the Economic and Social Research Council (ESRC) funded seminar series CASCADE-NET – Civil Agency, Society and Climate Adaptation to Weather Extremes. The seminar series, led by the University of the West of England, looks to answer how people interpret climate risks in social learning, including the role of social platforms and social networks for knowledge sharing and capacity building (in increasing the agency of civil society in extreme weather resilience). The outcomes from the seminar series will inform research and policy agendas for adaptation in the future.

Working with the rest of the world

The Welsh Government is a member of the RegionsAdapt framework, which sits within the Network of Regional Governments for Sustainable Development (Regions4). The Regions4 acts as the voice of subnational governments at UN negotiations, European Union initiatives and global discussions on environmental and sustainable development affairs. With RegionsAdapt, we work to inspire and support regional governments to take concrete action, collaborate and report efforts on climate change adaptation. The Welsh Government will continue to collaborate and share knowledge with other states and regions within the group to enable adaptation at a global level.

Case Study – Nature Based Solutions

Bringing together sub-national governments willing to ensure a nature based approach to decarbonisation and climate change adaptation is a key pillar of our climate action.

Recognising this, the Welsh Government introduced a Nature Based Climate Action Memorandum of Understanding (MoU) at the United Nations Framework Convention on Climate Change (UNFCCC) Conference of Parties (COP) 21 in Paris, 2015, alongside the sub-national governments for Basque, Catalonia, Manitoba, Quebec and Sao Paulo.

The MoU:

- brings sub-national governments together willing to ensure that nature based solutions are a mechanism of climate action
- offers an opportunity for states, regions, and cities to share ideas and best practices on the role nature based solutions offer for climate adaptation and mitigation
- provides a model for other sub-national governments to join
- provides a platform for collaboration and cooperation opportunities to increase technical and scientific understanding.

Signatories of the MOU have committed to:

- promote investments to enhance ecosystem resilience as part of the response to climate change
- look to natural and green infrastructure solutions
- use tools and assessments that promote a greater understanding of the wider value of biodiversity and healthy ecosystems
- develop tools that measure the benefits of joined up approaches
- increase technical and scientific cooperation.

The MoU is available to view at:
www.gov.wales/nature-based-climate-action-memorandum-understanding

Through the EU-funded Ireland Wales Programme 2014-2020, adaptation of the Irish Sea and Coastal Communities to Climate Change is designated one of three priorities for action. Examples of projects supported by this programme are detailed below in the 'Protecting our Coast and Seas' chapter. The programme enables co-operation with Ireland to preserve and enhance the shared marine and coastal environment in the face of climate change.

The Welsh Government also supports a number of other initiatives to help other countries across the world. Size of Wales was created by the Wales' Millennium Development Goals Task Force as part of Wales' response to the dual challenges of climate change and international poverty reduction. The aim of Size of Wales is to bring people in Wales together to help sustain an area of tropical forest "the size of Wales" (some two million hectares) as part of a national response to climate change.

The goal was reached in March 2013 and, since then, Size of Wales and its supporters have set a new target of protecting an area of rainforest equivalent to "twice the size of Wales" (four million hectares). The Welsh Government funding to Size of Wales also supports a climate change education and awareness raising programme, to encourage the people of Wales to help tackle climate change by taking simple positive action.

Size of Wales has close links with the "10 Million Trees" tree-planting project in Mbale, Uganda, which receives ongoing funding under the Welsh Government's Wales for Africa programme. This project has already planted over 8 million trees and forms a key part of the education and engagement work carried out by Size of Wales. It showcases pioneering work in providing incomes for farmers and families through fruit and coffee crops and bee-keeping, shade for animals and people, soil stabilization, as well as providing a carbon store for emissions. Size of Wales also support the Welsh Government "Plant!" scheme run by Natural Resources Wales where two new trees are planted for every new birth and adoption of a child in Wales, one in Wales and one in Mbale, Uganda.

Educating our children on global environmental issue and the impacts of climate change is also part of the Welsh Government's response. We support the delivery of the International Eco-Schools programme that engages millions of children across some 67 countries, making it the largest environmental educational programme in the world.

In Wales, the Welsh Government funds Keep Wales Tidy to operate the Eco-Schools programme. It covers over 90% of schools representing over 430,000 pupils in Wales, one of the highest participation rates in the world. The programme is designed to empower and inspire young people to make positive environmental changes to their schools and wider community while building on their key skills and encompassing education for sustainable development and global citizenship. Many schools across Wales have undertaken projects learning more about climate change and its impacts.

Case study – Powys Moorland Partnership

In Powys, the Powys Moorland Partnership (£600k Rural Communities – Rural Development Programme – Sustainable Management Scheme grant) has a programme of visits for school groups up onto the moorlands managed by the project. There they learn of the importance of peatlands in carbon storage along with its critical water management role in mitigating climate change events such as flash flooding. Much of the upland restoration work up on these moorlands, the children are involved with, create more resilient ecological networks increasing the protection against the effects of climate change. This coupled with storytelling from The Mabinogion reinforces both the ecological and cultural importance of these fragile landscapes.

Adaptive nature and the rural economy

This first sector-based chapter focuses on the actions needed to ensure our natural environment and rural economy remains resilient against the impacts of climate change.

Climate change and biodiversity loss are inseparable threats to humankind and must be addressed together. Biodiversity and climate are interconnected in many ways. On the one hand, biodiversity is strongly affected by climate change, with negative consequences for human well-being and the long-term stability of critical ecosystems. On the other hand, the conservation of biodiversity, through the ecosystem services it supports, makes an indispensable contribution to addressing climate change.

Better protection, management and restoration of natural and managed ecosystems can make significant contributions to the mitigation of human-induced climate change. Ecosystem-based approaches can also contribute significantly to climate change adaptation and disaster risk reduction thereby reducing the vulnerability of people, especially indigenous people and local communities and those disproportionally impacted, and the ecosystems upon which they depend, in the face of climate change.

The State of Natural Resources Report, the State of Nature Report and UK National Ecosystem Assessment confirm the continuing decline of biodiversity, ecosystems and the services we derive from our natural resources. This has been caused by, amongst other things, the loss and fragmentation of semi-natural habitats, pollution, exploitation of ecosystems and natural resources, and invasive species. Climate change is an over-riding factor, interacting with all of the above to produce additional stress.

The UNFCCC Paris Agreement places a fundamental priority of safeguarding food security and the particular vulnerabilities of food production systems from the impacts of climate change. Indeed, the CCRA Evidence Report suggests climate change will bring a number of significant challenges for the natural environment and agriculture. For example, all classes of crops and livestock are at risk from episodic events of heavy rains and droughts. The resulting impact and consequential loss could be felt for some years to come, both financially and physically. Conversely, there may be options to diversify into alternative crops and land management options. Nevertheless, due to other physical limitations, such as gradient, stone, rock outcrops and soil depth, Wales has up to

80% of its Utilised Agricultural Area (UAA) classed as Area of Natural Constraints (ANC). This creates other challenges that can be difficult to overcome such as distance from markets and processing facilities, as well as poor infrastructure. Understanding the challenges and risks, and identifying options and actions is therefore an essential step in developing a strategic approach to climate change for this sector.

There is a consensus that climate change will potentially favour Invasive Non-Native Species (INNS) leading to increasing numbers of new species and spread of established INNS. As a result the Welsh Government works in support of the GB Invasive non-native species strategy[14]. Changes in temperature are likely to stress native species, decreasing resistance to invasion. Similarly, increased frequency of episodic events such as flood and fire could benefit INNS. More work is needed to understand these sorts of interactions in the future. Changes in agricultural and forestry productivity may also lead to increased/changing use of pesticide. Increased occurrence of winter floods and summer droughts is likely to lead to a greater volume of pesticides being lost to watercourses as well as a higher risk of erosion occurring on exposed soils.

As the climate warms, the distribution of species is expected to be driven northward and to higher altitudes, bringing challenges to agriculture and the maintenance of biodiversity. There is already strong evidence that climate change is affecting UK biodiversity and impacts are expected to increase as the magnitude of climate change increases. Many species are being recorded further north, including some which have colonised large parts of the UK from continental Europe. There are also examples of shifts to higher altitudes. Some habitats are particularly sensitive to climate change; the risks are clearest for montane habitats (due to increased temperatures), wetlands (due to changes in water availability) and coastal habitats (due to sea-level rise). Further changes in climate will increase the risk of a breakdown in the synchrony between different species' life-cycle events. Food chain mismatches are most likely in highly seasonal species that depend on a synchronised food peak; the link between abundance of caterpillars and the reproductive success of woodland birds is one example of the importance of such synchrony.

There is now clear evidence that land management decisions can influence the impacts of climate change on species and ecosystems. Protected areas increase the chances of species persisting or expanding under climate change; however, effective adaptation to climate change will also require measures to enhance ecosystem resilience in the wider countryside. However, more research into the impacts and response options for biodiversity in the face of climate change is needed.

Part 1 of the Environment (Wales) Act 2016 sets out the sustainable management of natural resources in response to these pressures and challenges, and the priorities in the *Natural Resources Policy* are designed to address them. There is also a legal duty imposed by Part 1 on our environmental regulator NRW to pursue SMNR.

Urgent Risks

- Risks to habitats due to inability to respond, and opportunities from new species colonisations.
- Risks and opportunities from changes in agriculture and forest land suitability.
- Risks to carbon stores and sequestration.
- Risks to soils from increased aridity/wetness.
- Risks to agriculture and wildlife from water scarcity and flooding.
- Risks to freshwater species from higher water temperatures.
- Risks of land management exacerbating climate change risks.
- Risks and opportunities from long-term, climate-related changes in global food production.

The gaps

- Our protected sites, together with the wider resilience of Wales' ecosystems, will need more attention to improve their ecological condition in the face of climate change.
- Investment is needed in green infrastructure to help create resilient ecological networks and support nature based solutions to better adapt to climate change in our urban areas.
- More action is needed to restore peatland habitats.
- Research is needed to assess the suitability of agricultural and forestry systems in the face of soil aridity and drought.
- Action is needed to improve the identification, condition and monitoring of degraded soils from damaging land management practices in wetter and drier conditions.
- More effort is needed to improve water management practices to reduce the impact of low and high flows and more planning is needed for water scarcity in vulnerable locations.

Adaptive nature and our rural economy

Protecting our coasts and seas

Staying healthy

Safe homes and places

Protecting our heritage

Successful businesses

Infrastructure and transport

Cross-sector working

Ensuring we have a natural environment and rural economy which is resilient to the impact of climate change brings benefits from across all sectors and will require involvement from all. Part 1 of the Environment (Wales) Act 2016 puts in place the legislative framework to take forward joined up, collaborative, action to ensure Wales' natural resources and ecosystems are resilient and able to support our well-being now, and in the future; the 'sustainable management of natural resources'. The delivery framework consists of:

- the State of Natural Resources Report, which is the national evidence base and takes into account the CCRA evidence report.
- the Natural Resources Policy, which sets out the Welsh Ministers national priorities for the sustainable management of natural resources.
- area statements, which implement the Natural Resources Policy 'on the ground'.

The national priorities in the Natural Resources Policy are actions for everyone, and will require cross-sector working to deliver them. They are:

- delivering nature based solutions
- increasing resource efficiency and renewable energy
- taking a place based approach.

The following nature based solutions are particularly important for this chapter:

- developing resilient ecological networks
- increased canopy cover and well located woodland for greatest ecosystem service value
- maintaining, enhancing and restoring floodplains and hydrogeological systems to reduce flood risk and improve water quality and quantity
- restoration of uplands and managing them for biodiversity, carbon, water, flood risk, energy and recreational benefits.

Enabling farmers to work sustainably protects our food source, without which there would be potential impacts on our diets and health. Our efforts will also make sure that our farmers, land owners and foresters can continue to make a living. Much of the land and rural communities we are looking to protect is of national, historical and cultural importance. Climate change will impact on historic landscapes, upland communities, parks and gardens so it is also important that we protect these people and places for future generations.

AN1 Resilience	Restoration of uplands and managing them for biodiversity, carbon, water, flood risk, energy and recreational benefits.

Welsh Government will continue work to restore uplands, such as peatlands, to ensure they continue to provide a wide range of ecosystem services into the future, safeguard our terrestrial carbon stocks and limit GHG emissions.

Sub Actions	• NRW to develop a National Peatland Action Programme with costed proposals for the provision of a 5 year restoration programme. • Continue delivery of 'Peatlands for the Future'. • Continue a prioritised programme of restoration of afforested deep peatlands on the Welsh Government Woodland Estate.
Outcome on climate risk	Uplands, including peatlands in good ecological condition, are more resilient to climate change helping to support priority habitats, safeguard carbon stocks, limit GHG emissions and regulate the flow of water, smoothing out flood peaks and ensure a supply of base-flow during drought periods.
Stakeholders	Natural Resources Wales Non-Governmental Organisations Action groups Academia Land owners and managers Local Authorities
Delivery partners	Natural Resources Wales Welsh Government Land owners and managers

AN2 Resilience	Increased canopy cover and well located woodland for greatest ecosystem service value, climate change adaptation and mitigation.

The Welsh Government will continue to improve the resilience and extent of woodlands in Wales to provide a carbon store and help other land uses e.g. agriculture, biodiversity and urban areas to adapt to the impacts of climate change.

Sub Actions	• Promote and encourage integration of woodland with other land uses to enable them to adapt to climate change, with a view to reflecting this in future support mechanisms. • Maximise adaptation benefits in the design of the First Minister's National Forest Programme. • Use the statutory and policy framework in Wales to expand the woodland resource in appropriate locations. • Continue to bring special sites, Plantations on Ancient Woodland Sites (PAWS) and priority habitats into favourable management on the Welsh Government Woodland Estate (WGWE) and encourage private land owners to do so. • Promote the use of i-tree Eco and similar tools to highlight the ecoservice value of peri-urban/urban trees and assist in pest/disease incidence management. • Promote resilience to increasing incidence of arboricultural pests and diseases. • Develop and maintain a risk register of pests and diseases and their threat to tree health in Wales.

Outcome on climate risk	Increasing woodland cover in the right areas helps to counteract the impacts of climate change. Woodlands are an important asset to adaptation, for example to improve air quality, increase biosecurity on farms, reduce erosion and protect soils, buffer water courses, mitigate flood risk and provide cooler environments around urban areas. Our actions will also reduce the impact of climate change to woodlands themselves, by increasing their resilience pests and diseases and protecting the biodiversity they support.
Stakeholders	Natural Resources Wales Animal and Plant Health Agency Non-governmental organisations Charity action groups Academia Land owners and managers Local Authorities
Delivery partners	The Welsh Government Natural Resources Wales Animal and Plant Health Agency Non-governmental organisations Charity action groups Academia Land owners and managers Local Authorities

AN3 Resilience

Develop resilient ecological networks.

Spatially defined areas linking protected sites and other biodiversity hotspots across the wider landscape with good existing or potential functional connectivity. Such networks have existing or potential for healthy resilient ecosystems which provide a range of important ecosystem services as well as allowing the movement of species across landscapes in response to climate change.

Sub Actions	• Develop evidence base for resilient ecological networks to sit alongside ecosystem service mapping for area statements to inform place based working. • In line with our Natural Resources Policy and Nature Recovery Action Plan, promote resilient ecological network delivery across all relevant policies and programmes, including the development of the Sustainable Farming and our Land programme. • Assess the condition of the protected site network and put in place appropriate restoration management measures, as identified in our Nature Recovery Action Plan (NRAP). • Promote the use of nature based solutions through area statements and across sectors to contribute towards these networks. • Develop and agree actions for implementing the NRAP objectives.
Outcome on climate risk	The health and resilience of our ecosystems is incrementally improved so that they continue to support biodiversity and deliver important ecosystem services in the face of climate change.
Stakeholders	The UK Government and Devolved Administrations Natural Resources Wales Conservation NGOs and fora Land owners and managers
Delivery partners	The UK Government and Devolved Administrations Natural Resources Wales Conservation NGOs and fora Land owners and managers

AN4 Resilience

Protect our natural habitats from the increasing risks associated with invasive non-native species.

The Welsh Government will continue to encourage actions to control and reduce the spread of invasive non-native species, so as to reduce their impact on natural habitats and wildlife.

Sub Actions	• Collaborate on and implement actions in the GB invasive non-native species (INNS) strategy. • Incorporate biosecurity measures into marine proposals to reduce the risk of introducing and spreading marine INNS. • Co-ordinate, set priorities and raise awareness of INNS in Wales through the Wales INNS group. • Introduce contingency plans to respond to newly arrived INNS. • Implement EU Invasive Alien Species Regulation obligations.
Outcome on climate risk	Climate change has been shown to increase the numbers and populations of INNS in Wales's territorial and marine ecosystems. These actions will support ecosystems from the threats of climate change.
Stakeholders	The UK Government and Devolved Administrations Natural Resources Wales GB Non-Native Species Secretariat Conservation NGOs and fora Land owners and managers
Delivery partners	The Welsh Government Natural Resources Wales Conservation NGOs and fora Land owners and managers

AN5 Capacity

Maintain, enhance and restore floodplains and hydrogeological systems to reduce flood risk and improve water quality and quantity.

The Welsh Government aims to increase the role of nature based solutions in flood and water management.

Sub Actions	• Utilise the evidence base and collaborations being developed through area statements to deliver targeted interventions in catchments. • Promotion of good environmental, agricultural practice to increase resilience of soils and water which includes good soils and nutrient management plans. • Implement our River Basin Management Plans. • Promotion of the UK Forest Standard and the benefits of certification through the UK Woodland Assurance Scheme, improving uptake of sustainable forest management and protecting soils and water.
Outcome on climate risk	Flood and drought are two significant risks from climate change to Wales. The use of nature based solutions is known to be an effective measure to adapt to the risks caused by these impacts. This links to strategically increasing woodland canopy cover in line with the UK Forest Standard on good design and management practices, outlined at AN2.
Stakeholders	Natural Resources Wales Dwr Cymru/Hafren Dyfrdwy Local Authorities Land owners and managers Trusts Third sector Universities
Delivery partners	The Welsh Government Natural Resources Wales Conservation NGOs and fora Land owners and managers

AN6 Capacity

Deliver climate change adaptation through the new *Sustainable Farming Scheme for Wales*, by establishing and delivering a set of agriculture emission reduction and adaptation measures to support the agriculture industry in responding to climate change.

The Welsh Government to consider the impact of climate change under the new funding scheme to ensure it promotes actions which have positive impact on resilience, such as integrated woodland and peatland restoration, while avoiding actions which increases the risks associated with climate change.

Sub Actions	• Consult on the Sustainable Farming and our Land Following the analysis of responses to 'Sustainable Farming and our Land' we propose to develop a scheme which considers climate change and reduces the related impacts from agriculture on the environment as part of the development of Sustainable Land Management. The measures and outcomes set out in such a scheme will form the basis of wider adaptation and mitigation measures for the agricultural sector. • Co-design the new support scheme with the agricultural industry and stakeholders. • Develop evidence and modelling to aid policy through the Environment and Rural Affairs Monitoring and Modelling Programme (ERAMMP) with widespread stakeholder engagement. • Develop Sustainable Brand Values for food products to earn market recognition for delivering environmental outcomes.
Outcome on climate risk	Reduction of the risks of climate change through adaptation to changes while avoiding actions which may increase the risks.
Stakeholders	The Welsh Government Natural Resources Wales Farming unions Agriculture bodies WEL member organisations and Environmental NGOs Woodland organisations Water companies
Delivery partners	The Welsh Government Natural Resources Wales

AN7 Knowledge

Deliver the Capability, Suitability and Climate (CSC) programme.

The Welsh Government will work alongside academia to increase its understanding of the impacts of climate change on agriculture and land management, review the options available to mitigate these impacts and consider further mitigation options for the future.

Sub Actions	• Produce agricultural capability maps using the UK Climate Projection (2009 and 2018) data sets. • Assess the potential suitability of different crops under the different climate change scenarios. • Identify future research and adaptation needs for land use.
Outcome on climate risk	Increased understanding of the risks presented by climate change will contribute towards the development of tools and data supporting land managers in adapting to climate change.
Stakeholders	The Welsh Government Natural Resources Wales Farmers and Land Managers
Delivery partners	Aberystwyth University (IBERS) Natural Resources Wales Environment Systems Cranfield University RSK ADAS Ltd

Uplands and peatlands

Functional peatland areas offer significant benefits in terms of wild-fire management, carbon storage, habitat, water management, landscape character and archaeology.

Welsh peatlands support a rich suite of habitats and species including 7 habitats listed under Annex 1 of the Habitats & Species Directive amounting to a total estimated area of 56,248 ha.

The importance of deep peat for biodiversity is reflected by the inclusion of 47,440 ha of deep peat (just over half of the total Welsh resource) across 250 SSSI, with peatland habitats featuring as one of the primary qualifying features on 169 of these sites.

Peatland restoration has an important role to play in the declared climate change emergency and in contributing towards the First Minister's ambitions for improving biodiversity across the country.

As such, the restoration of peatland soil is an important component of land use management for climate change adaptation, as well as the wider benefits for water, flood risks and the rural economy. They are also home to a significant amount of archaeological material.

Restoration of Wales' uplands involves reversing trends of drainage and intensive management. This will secure the ecosystem's role as a critical carbon store and a key part of the nation's water supply. Positive management of upper catchment landscapes will enhance the uplands' ability to absorb and retain rainwater, extending catchment response times and contributing to improved community and infrastructure resilience to severe weather events. Restoration of Wales' upland environments also enables the environment to remain a major draw for tourists, making an enhanced contribution to the economy through eco-tourism, outdoor recreation and cultural destinations.

Where woodland removal is proposed for peatland habitat restoration, there should be full consideration of the impact on decarbonisation polices and net carbon impact should be assessed. Woodland should only be removed where sites have a high likelihood of a successful restoration and a peatland restoration plan is in place. Natural Resources Wales have undertaken an assessment of the carbon status of the Welsh Government Woodland Estate (WGWE) in terms of emissions and sequestration. This will help inform management decisions such as restoring and expanding key peatland habitats. A number of sites have been identified on the WGWE for this purpose subject to available resources. Welsh Government is also providing match funding of £1.059m to an EU LIFE funded programme on raised bogs in Wales. The project, led by Natural Resources Wales and receiving £3.28m in EU funding, aims to improve seven of the most important raised bog sites in Wales and will run to 2020. The Welsh Government is also funding an All Wales Peatland project through the Rural Communities – Rural Development Programme Sustainable Management Scheme.

Peatlands in good ecological condition provide the best conditions for maintaining carbon storage and limiting GHG emissions. However, adverse management of peatland in terms of drainage can result in the loss of carbon to the atmosphere as CO2 and as particulate organic carbon. Therefore, our peatlands restoration work will also reduce the risks from climate change by increasing resilience of soils from increased aridity and wetness. Our actions will go a long way to put a stop on the feedback cycle which damages our peatlands and the natural ability of our soils to store carbon. As such, the Welsh Government's future Peatland Policy ambition is:

To *"bring under sustainable management all areas of peat supporting semi-natural habitat"* with the dual target of:

i. ensure all peatlands with semi-natural vegetation are subject to favourable management/restoration (a minimum estimated area of 30,000 ha)

ii. restore a minimum of 25% (~c. 5,000 ha) of the most modified areas of peatland (i.e. those currently under conifer/improved grassland) to functional peatland ecosystems.

Delivery of the ambition with wider stakeholders relies on a series of actions and future programmes:

- the development by NRW of a National Peatland Action Programme with costed proposals for the provision of a 5 year restoration programme for consideration by Welsh Ministers in 2020
- the continuing development of a baseline assessment of peatland in Wales
- how peatland management and restoration features in future land management interventions
- the approach taken by NRW to area statements enabling action on the ground for targeted restoration. Area Statements will be produced by March 2020.

Woodlands and trees

Creating new woodland and managing existing woodlands are key components of our emissions reductions goals. We need to plant more woodlands and ensure we are managing our existing woodlands to protect the woodland carbon sink in both the woodland and the carbon rich soils below. Integrating trees, woodland and shrubs with agriculture and other land uses will increase soil carbon stocks and contribute to wider sustainable management objectives of improving water quality and soil fertility. Trees and woodland contribute to adaptation in urban areas through providing shade and integration with green infrastructure projects.

Woodlands provide a wide range of benefits for society, from abating carbon emissions and playing a role in reducing flood risk in sensitive locations through to being increasingly important as community resources, providing places for active recreation, education and lifelong learning. The First Minister has committed to the development of a National Forest Programme for Wales, which will deliver on a range of priorities, including climate change. The 'right tree in the right place' plays a key role in realising those benefits.

An increase in woodland cover is essential to the delivery of the climate change and decarbonisation obligations of the Welsh Government. The Welsh Government has set a new short-term target to increase woodland cover by at least 2000 hectares per annum from 2020 to 2030 and beyond. These new woodlands will include large and small, conifer, mixed and broadleaved plantings to deliver a range of ecosystem benefits, particularly when integrated with other land uses, as well as sequester carbon. Planting will be undertaken in accordance with UK Forestry Standard (UKFS) where planting on deep peat and environmentally sensitive land is avoided. The UKFS is the Government's reference standard for sustainable forest management in the UK, set in the context of Natural Resources Policy for Wales. The design of woodlands should seek to mitigate the effects of climate change and maximise multiple ecosystem benefits appropriate to the site. Guidelines on how to meet the UKFS requirements are set out in sub-sections covering biodiversity, climate change, historic environment, landscape, people, soil and water.

Woodland creation is currently supported through Welsh Government's Glastir programme. Our current consultation on future farm support makes clear that the sustainable land management approach requires us to consider wider societal needs when assessing which outcomes should be supported. As the consultation sets out, it is our view that tree planting should form a significant part of our efforts to increase carbon sequestration.

As stated in our Woodland for Wales Action Plan, we will continue to bring identified special woodland sites, Plantations on Ancient

Woodland Sites (PAWS) and native woodlands and priority habitats into favourable management on the Welsh Government Woodland Estate (WGWE). We will also encourage private landowners to do the same. The protection, gradual restoration and management of woodland habitats including ancient woodlands will increase their resilience to the impacts of climate change and better support the wide range of species that depend upon them. Progress is being made by Natural Resources Wales on the restoration of selected PAWS sites to a more natural state on the WGWE, as well as management of protected sites and woodland habitat network improvement projects. The planting of new, native woodlands for biodiversity, as well as expanding and improving connectivity for existing woodland habitats, also contributes to resilience.

We are keen to ensure our woodlands are resilient to the increasing incidences of pests and diseases likely through climate change. An example is *P.ramorum* or 'Sudden Oak Death' which is an exotic fungus-like pathogen known to affect a wide range of host plants. While the management of the disease has had a devastating effect on larch in Wales, it has provided opportunities to improve the age structure and increase the species diversity of Welsh woodlands which contribute to landscape and future resilience.

The biodiversity, cultural and landscape value particularly of ancient, veteran and heritage trees is well documented. Our woodlands act as areas for recreation and means of income, bringing benefits to health, our communities and the economy. However, the measures to protect them could be improved. Pests and diseases have significant potential to impact on the health of trees and woodlands and undermine their timber productivity and the benefits they provide as habitats. The creation and maintenance of a risk register for Wales is central to monitoring threats, taking into account climate change and informing decisions on effective tree health control, woodland management and species selection. Welsh Government and NRW will participate in the GB and NI Tree Health Advisory Group to ensure that Wales has access to the latest information about management approaches to pests and diseases across the UK countries. Local authorities undertaking a survey of woodlands through i-Tree Eco or a similar tool enables a fast response in the event of disease outbreaks. It also demonstrates the value of urban trees and woodland as ecosystem assets.

A woodland creation opportunity/sensitivities map is available which will guide collaborative action on the range of opportunities for planting trees for greatest ecosystem service benefit, and this will be reviewed to reflect new data bases. Natural Resources Wales' area statements will also enable action on the ground.

Biodiversity

We need to develop resilient ecological networks to support reversing the decline in biodiversity. Resilient ecological networks are about linking up Wales' protected sites with other biodiversity hotspots and the wider countryside, so that species are able to move within them as required for all stages of their life cycles. Developing networks will involve targeted habitat restoration, controlling invasive non-native species and the development of landscape-scale projects and nature-based solutions. Importantly these networks with their enhanced diversity, extent, condition and connectivity provide healthier more resilient ecosystems which are able to continue delivering important ecosystem services such as water and flood management in the face of a changing climate. Their development therefore needs to be informed by an understanding of the potential for ecosystem service delivery as well as the biodiversity and resilience aspects which underpin them.

Natural Resources Wales' area statements to be produced by March 2020 will identify opportunities for the development of resilient ecological networks and enable collaborative action on the ground. An example of current work by an eNGO in this area is he publication by Buglife Cymru of 'B-Lines' across Wales aims to create and restore at least 150,000 hectares of flower rich habitat (at a UK level) aiming to link existing wildlife areas together, benefitting the dispersal of bees and butterflies and other pollinators and wildlife.

This action is required by the Natural Resources Policy and will be implemented through the Natural Resources Management Framework put in place by the Environment (Wales) Act 2016 and by our Nature Recovery Action Plan which has the following objectives to reverse the decline of biodiversity in Wales:

- engage and support participation and understanding to embed biodiversity throughout decision making at all levels
- safeguard species and habitats of principal importance and improve their management. Including the requirement on Welsh Ministers to prepare and publish a list of the living organisms and types of habitat which are of principal importance for the purpose of maintaining and enhancing biodiversity in Wales
- increase the resilience of our natural environment by restoring degraded habitats and habitat creation
- tackle key pressures on species and habitats
- improve our evidence, understanding and monitoring
- put in place a framework of governance and support for delivery.

NRW's LIFE Natura 2000 (N2K) Programme has created 11 Thematic Action Plans (including climate change, non-native invasive species and pathogens and habitat fragmentation) detailing priority actions to address major issues and risks which will have an adverse impact on N2K features across the network. Actions include:

- ensure that maintaining and enhancing the features of N2K sites in the face of climate change is fully integrated within the implementation of the Nature Recovery Action Plan as critical components of ecosystem resilience
- ensure that climate change implications for marine N2K sites are considered in the Marine Plan, including investigating impacts of changing fisheries practice due to climate change
- complete habitat and species network/connectivity mapping for all groups of N2K habitats and species
- integrate biosecurity best practice into appropriate regulatory regimes, to ensure that risks to N2K features posed by INNS are effectively managed.

Natural Resources Wales' area statements will also enable action on the ground. Area Statements will be produced by March 2020, maps have also been produced which guide collaborative action on the development of resilient ecological networks.

Invasive Non-Native Species

Climate change has the potential to favour Invasive Non-Native Species (INNS) leading to increasing numbers of new species and the spread of established INNS. Many non-native species which are already established in Wales but do not currently demonstrate invasive qualities, may exhibit invasive qualities in response to climate change. Grey squirrel which is an established

INNS and is already having a significant impact on our woodlands damaging woodlands planted to mitigate climate change.

As well as the need to create more effective means of detecting and monitoring the spread of INNS in Wales we need to be able to more accurately predict INNS which are likely to be positively impacted by climate change and those which are likely to become invasive as a result of climate change. We will work with UK authorities to undertake a new Horizon Scanning exercise in 2020.

The Welsh Government works in collaboration with its partners in Wales and across GB to deliver the GB Invasive Non-Native Species Strategy seeking to tackle the threats posed, and to prioritise actions to control and eradicate INNS. Our draft Welsh National Marine Plan includes a requirement that marine proposals should 'include biosecurity measures to reduce the risk of introducing and spreading invasive non-native species'. We will co-ordinate our priorities on INNS with the Wales INNS Group. We will legislate to introduce measures to enforce breaches of the Invasive Alien Species (Enforcement and Permitting) Order 2019 which is due to come into force on 1 December 2019, develop and introduce Pathway Action Plans to address priority pathways of unintentional introduction and spread of INNS, and have provided additional funding to NRW to ensure long-term, dedicated INNS capacity within the organisation. In addition, we will develop contingency plans for INNS animals and plants in the terrestrial, freshwater and marine environments to be able to rapidly respond to the incursion of significant new INNS.

Natural Resources Wales' area statements, to be produced by March 2020, will identify opportunities for the development of resilient ecological networks, including the control of INNS, and enable collaborative action on the ground. INNS have been selected as one of the cross cutting themes for the forthcoming State of Natural Resources Report (SoNaRRI2). SoNaRRI2 is likely to differ from the original SoNaRR to help policy makers to use the data included in order to direct resources and action.

The recently approved Wales Resilient Ecological Network (WaREN) project under our 'Enabling Natural Resources and Well-Being in Wales' grant scheme aims to formulate a framework for collaboration, which will promote biodiversity and improve ecosystem resilience through the development of a-pan Wales approach for the effective sustainable management of INNS in a strategic, prioritised and joined up way.

The project will help set out the strategic direction for decision making for tackling INNS in a co-ordinated and targeted pan Wales approach. It will make clear links between natural resources and addressing wider multiple benefits including health and wellbeing; economic and social benefits.

The Welsh Government is also providing £2m of match funding, to the EU LIFE funded Celtic Rainforests programme. The purpose of this project is to improve the conservation status of four key Special Areas of Conservation for woodland in the north and west of Wales. These woodlands, due to their levels of humidity and associated biodiversity, support internationally important communities of lichens, mosses and bryophytes and significant populations of migratory songbirds. The project will remove INNS, such as Rhododendron Ponticum, and created "buffer-zones" to reduce the increased likelihood of re-infestation from neighbouring land. The overall project costs are £7.67m, with £4.59m from the EU, and a further £1.06m from other partners.

Floodplains and hydrological systems

This priority includes nature based solutions such as natural flood management and catchment based approaches to improving water quality and supply. Natural flood

management (NFM) is when natural processes are used to reduce the risk of flooding by actions such as:

- storing water by using, and maintaining the capacity of, ponds, ditches, embanked reservoirs, channels or land
- Increasing soil infiltration, potentially reducing surface runoff, although this can be offset by greater subsurface flows. Free-draining soil will make saturation less likely, and evaporation from soil can also make space for water
- slowing water by increasing resistance to its flow, for example, by planting floodplain or riverside woods
- reducing water flow connectivity by interrupting surface flows of water, for example, by water storage or planting buffer strips of grass or trees
- maintaining and enhancing existing semi-natural habitats and restoration of floodplain grasslands to help slow, store and filter floodwaters and reduce the effects of drought, soil and nutrients on rivers and lakes.

NFM also supports wider benefits by reducing erosion and benefit water quality, carbon storage & biodiversity.

Natural Resources Wales' area statements will also enable action on the ground. Area Statements will be produced by March 2020, and maps have also been produced which guide collaborative action on the range of opportunities for nature based solutions in catchments.

Our River Basin Management Plans will help ensure access to water for agriculture. River Basin Management Plans are an existing measure under the Marine Strategy Framework Directive (MSFD) contributing to improving the state of the UK's marine and coastal environments. The aim of the MSFD is for the UK to achieve Good Environmental Status in its waters by 2020. The plans consider the pressures facing Wales' water environment. Our rivers, lakes, wetlands, groundwaters, estuaries and coastal waters, including those in protected areas, all fall under these plans. They are updated on a six yearly cycle and are prepared in consultation with a wide range of organisations and individuals.

Sustainable Farming Scheme

Leaving the EU means leaving the Common Agricultural Policy (CAP) which provided the funding stream for agriculture and land management in Wales. This allows Wales to consider its support to farmers and land managers outside the confinements of the EU's Basic Payment and the Rural Development Regulations. Following extensive engagement with stakeholders the Welsh Government is consulting on future land management support in the 'Sustainable Farming and our Land' consultation.

The proposals is for a single support scheme designed to deliver Sustainable Land Management encompassing the triple bottom line of sustainability of economic, environmental and social categories of sustainability. There is significant interaction between the benefits and outcomes. For example, capturing (sequestering) carbon in soils through increased levels of soil organic matter not only has the benefit of a cleaner atmosphere, but also an impact on the productive capacity of the soil, leading to higher overall productivity and thus competitiveness. All of the economic and environmental outcomes can be directly or indirectly related to how a farmer manages their land to produce food. Alongside the consultation we also host co-design events which will allow us to explore the practical aspects of the new scheme which will help us to understand how best to deliver such scheme.

Sustainable agriculture

Throughout 2018, the Agriculture Industry Climate Change Forum worked in collaboration with Amaeth Cymru and wider stakeholders to develop a set of sustainable values across the supply chain from Farm to Fork. The work has

helped improve understanding of the threats and options arising from climate change, build adaptive capacity and increase resilience in the agricultural sector. As a result, an adaptation framework has been produced to contribute towards a Sustainable Brand Values Programme to be published in 2019. In collaboration with Aberystwyth University, we will continue to improve and share understanding of best practice of climate change adaptation in agriculture. The suggested avenues for adaptation include farm production practice, farm financial management, technological developments and governmental programmes. Actions could include:

Cropping Adaptations

- Research and uptake of crop/forage varieties for increased temperatures and drought tolerance.
- Forage varieties to increase water retention, reduce flood risk during extreme weather events through enhanced root development and soil water retention.
- Water management technologies to ensure greater water efficiency and to prevent negative impact from extreme precipitation and flooding by increasing the use of riparian zones.
- Changing crops/forages according to season and location.
- To minimise impact of animal feed costs, encourage home grown feed where possible and encourage more mixed farming practices to adapt to risks such as monoculture exacerbated by climate change.

Livestock adaptations

- Grazing management to maximise gains (timing, plant species) to prevent soil degradation and avoid build-up of pathogens.
- Extensive but appropriate conservation grazing to reduce wild fire risk and safeguard important habitat.
- Utilise genetic improvement and ability to select the animals best suited to changing condition such as heat stress.
- Nutritional management and diet regimes to maximise feed utilisation to adapt to the risks of feed shortages.
- Infrastructure changes to avoid heat stress in summer and protect against wet conditions in winter.
- Increase disease surveillance and importation control (especially for vectors).

Soils

Soil is fundamental to nearly everything we do. It is a finite natural resource which once lost, is gone forever. Soil sealing, degradation and climate change are significant global problems and Wales has a responsibility to understand, maintain and enhance its soils for the future generations.

The Capability, Suitability and Climate (CSC) programme will refine and link the predictive Agricultural Land Classification (ALC) map (land capability) to the latest climate projection data. This will allow the Welsh Government to model how agricultural land capability and suitability may change under different climate change scenarios. The agricultural land classification system uses seasonal averages meaning climate data may be used to assess soil wetness, droughtiness and timing/intensity of rain and temperature under different climate scenarios. Seasonality is important for crops – plants demand heat and rain at key points. The research will also be important in identifying risks between cropping options and soil. The programme will allow policy makers to start thinking about adaptation measures to tackle flood risk, droughtiness, environmental damage to soils and crop selection.

The refined predictive ALC map will also support the Welsh Government Planning Policy to conserve our most productive soils. It will allow land users, planners and policy makers to make informed decisions on the use of high quality agricultural land in the planning system.

Current action against other risks

Two further risks were identified in the Climate Change Risk Assessment relevant to this chapter, for which the UKCCC stated current action should be sustained to ensure their mitigation. These risks are:

Risks to agriculture, forestry, landscapes and wildlife from pests, pathogens and invasive species

Risks to agriculture, forestry, wildlife and heritage from change in frequency and/or magnitude of extreme weather and wildfire events

Our current action against these risks is summarised below.

Pests and diseases

In their CCRA Evidence Report, the UKCCC states that a warmer climate provides an increased likelihood of plant pests and diseases that were previously limited by climate. The potential increase of harmful pests and diseases will be monitored and mitigated through a number of strategic and operational actions.

We will develop contingency plans for significant plant pests to help eradicate or minimise the impact when outbreaks occur.

The global horticultural and timber trade has been a pathway of ecological pests and diseases for many years. Facilitating the movement of organisms such as *Phytophthora ramorum via Rhododendron* and *Hymenoscyphus fraxineus (Ash dieback)* in recent years. Both pathogens have gone on to establish throughout Wales and the UK with huge environmental, social and economic costs. The plant trade has also introduced many more pests and diseases from warmer countries which have been unable to survive due to the colder climate in the UK or have been intercepted by plant health inspectors. However, a warmer climate has the potential to increase survival rates of such pests and diseases. The Welsh Government works closely with the other Devolved Administrations, sharing information and knowledge to respond to interceptions and outbreaks. Forestry Commission, the Animal and Plant Health Agency (APHA) and Natural Resources Wales all play vital roles in delivering plant health functions on behalf of the Welsh Ministers.

Oak processionary moth (OPM) are pests of oak trees, and a hazard to human and animal health. OPM is established in most of Greater London and in some surrounding counties, but the rest of the UK is designated a Protected Zone. In July 2019, the UK Plant Health Service intercepted a number of cases, including in Wales, of OPM caterpillars on recently planted oak trees imported from the Netherlands and Germany. The multi-agency response lead by Forestry Commission has worked well with over 1800 sites being visited across the UK in 2 months and approximately 100 sites being eradicated as a result of infestation (3 of which were located in Wales).

OPM caterpillars will only emerge during sustained periods of warm weather. Climate change means it is likely that we see a rise in the reporting of OPM as they fly across the channel or spread from the areas they are established in Greater London. The Forestry Commission will continue to work with the Welsh Government, NRW, and APHA to provide surveillance and trapping programmes but we will need further collaboration if incidents like these are to become more common, in part due to climate change.

Extreme weather and wildfire

Extreme weather events leading to strong winds and dry weather can be a significant problem to agriculture forestry and wildlife. Projections show there will be increased potential due to climate change for wildfires and wind damage which needs mitigation. The UKCCC recognises that these risks are already well understood. The UK National Risk Register considers the risk of wildfire as seriously as it does other national risks such as flood and pandemic disease. There are individual emergency plans in place for these issues published by organisations such as the Forestry Commission and the Welsh Government works closely with emergency services and NRW to avoid these risks where possible. We will continue to monitor the impacts of extreme weather events on agriculture and forestry to mitigate issues where possible. *Ash dieback* has resulted in large scale clear-fells, these areas of restock are very susceptible to wildfires due to the grassy vegetation.

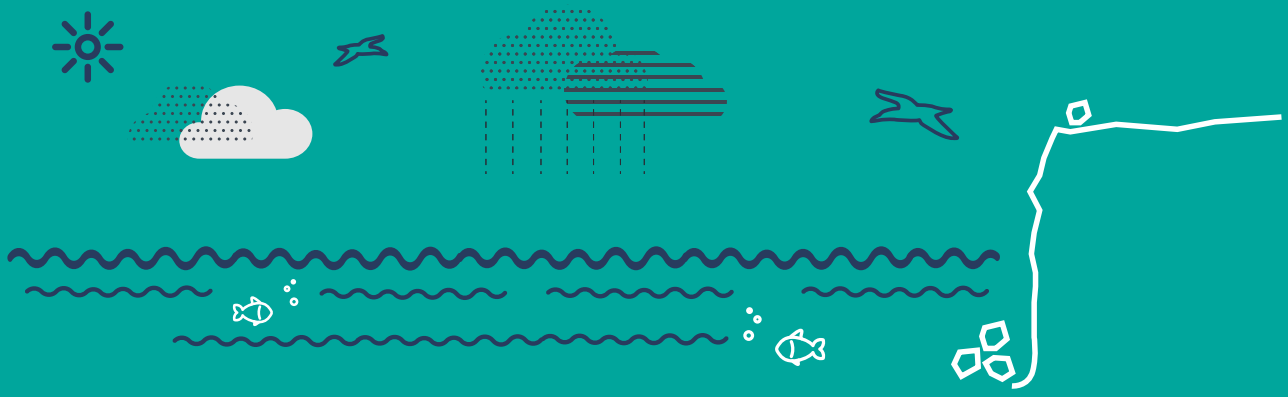
Agricultural and forestry practices

Changes in agricultural and forestry productivity and practices in response to climate change may lead to increased/changing use of pesticides. Increased occurrence of winter floods and summer droughts is likely to lead to a greater volume of pesticides being lost to watercourses as well as a higher risk of erosion occurring on exposed soils. The Welsh Government will continue to work with stakeholders to meet our policy aim of reducing to the lowest possible level the effect of pesticide use on people, wildlife, plants and the environment while making sure pests, diseases and weeds are effectively controlled. We do this by promoting requirements for appropriate training and certification; regular inspection of application equipment; and promoting the use of Integrated Pest Management (IPM) and of alternative approaches or techniques all aimed at protecting human health, water and biodiversity.

Welsh Water has been awarded almost £1m from Welsh Government's Rural Development Programme to deliver their pan Wales PestSmart Project[v]. The project will work with farmers, growers, landowners and gardeners across Wales, to help people and communities to consider the way they manage their land to help safeguard raw water quality. It will include advice on user best practice, investigate new technologies and undertake a wider pesticide amnesty.

v. See https://www.dwrcymru.com/en/WaterSource/PestSmart.aspx

Protecting our coasts and seas



This section of the adaptation plan is dedicated to impacts of climate change on the seas that surround our country and the coastlines that line them. Our coastal environment is at particular risk from climate change due to sea level rise and there is much at risk on our coasts. Many of Wales' largest towns, cities and communities face our seas. The coast is home to farms and businesses, forms much of our tourism and includes a significant number of historic assets, including archaeological sites and historic buildings and settlements.

Rising sea levels exacerbated by storm surges can harm our homes. Storms will likely become stronger and more common, so we need to be prepared to manage our coastal landforms and habitats and consider the long term effects.

Historic buildings and archaeological sites located in low-lying areas are at potential risk of loss or damage from predicted sea-level rise and more frequent storms. Such events can also expose previously hidden or unknown archaeological sites. To date our response has been largely reactive and limited to recording and investigation as loss is occurring. However, better outcomes may be achieved through planned and anticipatory adaptation. Attempts to respond to sea-level rise may themselves have an impact on the historic environment, whether in the construction of coastal defences or the creation of manageable habitats such as salt marsh.

Changes in water pH (mostly acidification) may also affect the long-term stability of underwater cultural heritage, increase attrition of metal objects and cause as yet largely unknown effects on timber. With increased storminess, the higher energy oceans bring more turbulence. As well as increased physical disruption to the foreshore and intertidal sites, changing currents and increased energy underwater will have an impact on submerged archaeology. Ocean acidification is known to be detrimental to biodiversity also. The UKCCC stated that it is highly likely that UK coastal waters will be impacted by the issue as CO2 emissions continue to rise. Research has shown some species are moving northwards to cooler seas and that the warmer seas are affecting the timing of sea migrations.

There may be new openings in this sector if changes to water temperature, acidity and productivity lead to increased fishery yields for example, but we still need to do more to understand the risks climate change may bring.

Urgent Risks

- Risks to habitats and heritage in the coastal zone from sea level rise and loss of natural flood protection.
- Risks to the viability of coastal communities from sea level rise.
- Risks to infrastructure services from coastal flooding and erosion (see 'Resilient Infrastructure and Transport').
- Risks and opportunities to marine species, fisheries and marine heritage from acidification and higher temperatures.

The gaps

- More work is needed to allow for dynamic readjustment of coastal landforms and habitats, particularly in terms of increased sediment supply and realignment opportunities.
- Further research is needed around the impacts of climate change on marine ecosystems and ecosystem services.
- Further research is needed to establish the baseline condition of underwater cultural heritage, to monitor change and understand the impacts of climate change.

Adaptive nature and our rural economy

Protecting our coasts and seas

Staying healthy

Safe homes and places

Protecting our heritage

Successful businesses

Infrastructure and transport

Cross-sector working

Our coastlines need particular attention to the risks brought by rising sea levels and storm surges caused by climate change. Many of our important assets are located along the coasts, meaning collaboration in our efforts to adapt is important.

While the coastline is home to a significant number of species whose habitats need protecting, it also a home for us – a large proportion of our cities, towns and communities will at risk. The coast and seas hold a significant amount of heritage, including many historic shipwrecks. Wales' economy depends considerably on tourism be along the coasts. Our businesses will need to adapt to the changing climate to ensure visitors continue to come, and we will of course need to ensure our digital and transport infrastructure is resilient to allow all of these sectors to continue running efficiently all the while.

Our commitments

MC1 Resilience	Improve the resilience of habitats and heritage in Wales' coastal zones from the impacts of climate change.
The Welsh Government is supporting delivery partners to manage the risks from climate change faced by the coasts of Wales, including its ecosystems, landscapes, heritage and communities.	
Sub Actions	• Understand the quality and quantity of existing habitats within the coastal zone and establish a programme of delivery of compensatory habitat around Wales. • Habitat compensation will be delivered in the long-term in line with the life of the Shoreline Management Plans. • Ensure that underwater cultural heritage considerations are included in relevant plans and policies (such as the Wales National Marine Plan) and seek to incorporate environmental monitoring into marine licensing conditions.
Outcome on climate risk	By doing more to understand the habitats impacted and then implementing habitat compensation through Shoreline Management Plans, we will protect habitats from sea-level rise and the loss of natural flood protection.
Stakeholders	Wales Coastal Monitoring Centre Natural Resources Wales National Trust Cadw
Delivery partners	The Welsh Government Wales Coastal Monitoring Centre Natural Resources Wales Cadw

MC2 Resilience	Provide updated policy and guidance on coastal adaptation.
The Welsh Government will review policy and put in place new guidance and tools to increase Wales' capacity to manage coastal flooding and erosion.	
Sub Actions	• The updated draft National Strategy for Flood and Coastal Erosion Risk Management in Wales, sets out how we intend to manage the risks from flooding and coastal erosion. • Develop and communicate a new Coastal Adaptation Toolkit. • Utilise the Wales Coastal Monitoring Centre to plan for risks.
Outcome on climate risk	New policy guidance and toolkits will provide the means for others to deliver actions against the impacts of climate change on our coastlines.
Stakeholders	The Welsh Government Natural Resources Wales Wales Coastal Group Forum Cadw Local Authorities
Delivery partners	The Welsh Government Natural Resources Wales Wales Coastal Group Forum Cadw Local Authorities

MC3 Resilience

Improve the condition of the wider marine ecosystem to enable resilience to the impacts of Climate Change.

The Welsh Government will work with stakeholders to monitor and manage marine ecosystems across 139 Marine Protected Areas, and the wider marine environment, in Wales.

Sub Actions	• Complete the network of Marine Protected Areas (MPAs) in Wales. • Improve the condition of features within designated sites. • Continue to work toward achieving and maintaining good environmental status in the marine environment.
Outcome on climate risk	Approaches to managing MPAs (and other designated sites) – via the MPA Management Steering Group will take into account latest research on, and hence reduce climate risks to, marine ecosystems.
Stakeholders	Wales Marine Action and Advisory Group Wales Marine Fisheries Advisory Group Natural Resources Wales Commercial partners
Delivery partners	The Welsh Government Wales Marine Action and Advisory Group Natural Resources Wales Wales Marine Fisheries Advisory Group Commercial partners

MC4 Knowledge

Carry out research to better understand the impact of climate change on marine ecosystems, ecosystem services and marine heritage.

The Welsh Government will support UK level research to inform our understanding of climate risks to marine ecosystems and cultural heritage.

Sub Actions	• Collaborate on research to improve knowledge of higher water temperatures on fish stocks and ecosystems, including impacts for fish disease and aquaculture. • Research opportunities for fishing industry diversification and/or increasing the value of current activities and future planning. • Establish the baseline state of the underwater historic environment and potential changes.
Outcome on climate risk	Improved knowledge of impacts of climate change on marine ecosystems and ecosystem services, answering research gaps to enable better decisions. Those involved in managing marine ecosystems and heritage will be better informed and therefore take climate risks into account in their decision making.
Stakeholders	Wales Marine Action and Advisory Group Wales Marine Fisheries Advisory Group Royal Commission of the Ancient and Historic Monuments of Wales Cadw UK heritage agencies Academia Commercial partners
Delivery partners	The Welsh Government Royal Commission of the Ancient and Historic Monuments of Wales Cadw UK heritage agencies Academia Commercial partners

Ireland Wales Programme

The EU funded Ireland Wales Programme 2014-2020 is a maritime programme connecting organisations, businesses and communities on the West coast of Wales with South-East Ireland. It provides opportunities for partners across the sea border to work together to address common economic, environmental and social challenges.

One of the three priorities of the programme is adaptation of the Irish Sea and Coastal Communities to Climate Change. Through the programme, capacity and knowledge of climate change adaptation across the Irish Sea and its coastal communities is being increased by sharing best practice and expertise by monitoring the impacts of climate change.

Four approved projects are underway under the programme:

- **Ecostructure:** Raising awareness of eco-engineering solutions to the challenge of coastal adaptation to climate change by providing developers and regulators with accessible tools and resources, based on interdisciplinary research in the fields of ecology, engineering and socioeconomics. Ecostructure aims to promote the incorporation of secondary ecological and societal benefits into coastal defence and renewable energy structures, with benefits to the environment, to coastal communities and to the blue and green sectors of the Irish and Welsh economies.
- **Bluefish:** Developing knowledge and understanding of the marine resources of the Irish Sea and Celtic Seas by addressing knowledge gaps regarding the effects on, and potential vulnerability of, selected commercial fish and shellfish from predicted climate change. Through the transfer of knowledge, transnational expertise and best practice with respect to study and management of commercial fish, shellfish and aquaculture under a climate change context, and through the strong marine science partnership of the consortium (including 4 Irish and Welsh HEIs), its aim is to provide region-wide adaptation strategies for the benefit of coastal communities.
- **Acclimatize:** Closing the knowledge gap in relation to the faecal pollution of 'at-risk' urban and rural bathing waters in Ireland and Wales by identifying and quantifying pollution streams and determining their impact on these waters through a dynamic period of climate change.
- **CHERISH**: Increasing cross-border knowledge and understanding of the impacts (past, present and near-future) of climate change, storminess and extreme weather events on the cultural heritage of reefs, islands and headlands of the Irish Sea (more detail in the 'Caring for the Historic Environment' chapter below).

One further project is being added to the programme to further the advances of adaptation in the marine environment. The STREAM (Sensor Technologies for Remote Environmental Aquatic Monitoring) project will bring together partners on both sides of the Irish Sea to better understand the impact of climate change, lower the cost of marine observation and accelerate the process of data provision. The €5.4 million project is led by the Waterford Institute of Technology, with project partners Swansea University and Cork Institute of Technology. Data collected will be shared locally to keep coastal communities informed about the local impacts of climate change.

Coastal communities

Sea level rise caused by climate change, along with increased incidence of storms, means the risk of coastal inundation and flooding of coastal communities is increasing.

There are a number of communities which are already vulnerable to spring tides and coastal surges – with projected sea level rise, some of those communities may become unsustainable. The Shoreline Management Plans (SMPs – see below) set out the preferred management strategies for dealing with this risk over the next century.

Shoreline Management Plans (SMPs)

SMPs are large scale assessments of the risks associated with coastal processes which help reduce the impacts to people, existing development, historic and natural environments. Their aim is to identify coastal risk management policies to reduce the risks to people and the developed, historic and natural environments, over the long term. SMPs identify the best approach or approaches to managing risks over 100 years (from 2005) from coastal erosion both for individual areas and the wider coast. SMPs set priorities for coastal Local Authorities to investigate options to protect the shoreline and develop schemes accordingly. The second iteration of plans was published in 2014 and forms the policy for long term management of risk along the entire shoreline of Wales. There are four SMPs covering Wales:

- SMP 19 Anchor Head to Lavernock Point (Severn Estuary)
- SMP 20 Lavernock Point to St Ann's Head (South Wales)
- SMP 21 St Ann's Head to Great Orme's Head (West of Wales)
- SMP 22 Great Orme's Head to Scotland (North West England and North Wales).

To strengthen our position, the Welsh Government has reviewed the National Strategy for Flood and Coastal Erosion Risk Management (2011) with a view to publication in early 2020. A measure will be included in the National Strategy to report on progress on SMP Action Plans, with an annual report being submitted to Welsh Government, from the Wales Coastal Group Forum.

Under the new Strategy, the Welsh Government is working with the Wales Coastal Group Forum (led by coastal Local Authorities) to develop a Coastal Adaptation Toolkit. The toolkit will include engagement guidance based on the lessons learned from Fairbourne[vi] to work with the community on coastal adaptation. By including coastal Local Authorities in the development of the Toolkit, we hope to improve, and build upon previous methods to engage with communities and improve resilience.

In addition, Welsh Government has recently provided 3 years funding for the Wales Coastal Monitoring Centre to collate and analyse data on the changing Welsh coastline which will help to inform decisions and priorities for coastal adaptation and potential schemes, on a national basis.

In 2014 Welsh Government established the £150 million Coastal Risk Management Programme to provide funding to local authorities for a concentrated period of investment (between 2019 and 2022) for coastal adaptation and risk management schemes. This programme will support local authorities in responding to the challenges of climate change and implement the actions and risk management set out in the SMPs. This Programme also focusses on reducing current and future risk to homes and businesses whilst also providing wider benefits wherever possible.

vi Fairbourne is a low lying coastal community on the Mawddach Estuary with around 300 properties. It is at risk from tidal, river and potentially groundwater flooding as sea levels rise. The West of Wales Shoreline Management Plan 2 recommends that the village is protected during epoch 1. In the medium term, however (over the next 50 years), the plan is for managed realignment.

The Welsh Government will be launching consultation upon revisions of planning Technical Advice Note 15 (on Development and Flood Risk) are also underway, which will include an amalgamation of Technical Advice Note 14 (Coastal Planning), to clarify our policy on planning and coastal adaptation.

Habitats

The integrity of protected (or nationally significant) coastal habitats in Wales is managed through the Conservation of Habitats and Species Regulations 2017 (termed the 'Habitat Regulations'). Habitat Regulation Assessments were undertaken for the 4 SMPs in Wales, which estimated the amount of compensatory habitat which will be needed to implement the various SMP policies over the 100 year period.

Those assessments may have used differing methodology to calculate the compensatory habitat needed (the target). In order to understand the impact on habitats from the provision of new coastal defences, we will refine the methodology (to be informed by the 'What is coastal squeeze?' research & development project) and establish an agreed target for all SMP policies in Wales. We will also establish how much sediment supply and erosion is happening around Wales to track the current impacts of climate change through the Wales Coastal Monitoring Centre. Where SMPs indicate the preferred future risk management policy is 'Managed Realignment', there is potential to create compensatory habitat as coastal defences move back, allowing habitats to be created in front of the defence.

The Welsh Government meets its Habitats Regulations requirements through the National Habitat Creation Programme (NHCP). The NHCP was established to scope for and provide any necessary coastal habitat compensation as a result of our flood and coastal interventions.

Case Study – Habitat creation in Cwm Ivy

Cwm Ivy on the Gower peninsula was a SSSI site of lowland fen meadow and freshwater ditches behind a sea wall defence, owned by the National Trust.

The Shoreline Management Plan policy for this section of the coast is No Active Intervention, meaning there is no planned investment in coastal defences as it is not cost effective to defend the coastline and the natural environment is capable of defending the coast.

At the time of developing the Shoreline Management Plan, the area of land in Cwm Ivy was noted as being strategically important as it provided an opportunity to create compensatory habitat to maintain the integrity of the Natura 2000 sites affected by coastal squeeze, as required by the Habitats Directive.

Until August 2014 the Wales Coast Path route crossed the sea wall; the route was diverted following a high tide breach of the sea wall. Further stormy weather in 2014 continued to accelerate the breach, allowing salt water to infiltrate the area behind the sea wall. NRW in partnership with the National Trust took this breach of the sea wall as an opportunity to implement the No Active Intervention policy at Cwm Ivy, i.e. not repairing the breach in the sea wall and achieving a long term sustainable solution returning the area to its natural state (i.e. before construction of the sea wall) as a saltmarsh within the estuary.

The site has the potential to create 38 Ha of habitat – primarily saltmarsh, in the long term. Early stages of saltmarsh habitat development are established in about a half of the site, which is on track with expectations. Discussions are ongoing with the Wales Coast Path and City and County of Swansea to develop a sustainable solution to the Wales Coast Path.

Ocean acidification

The Welsh Government recognises that there is limited knowledge available with regards to the anticipated effects of ocean acidification from climate change and the impacts this may have on the biodiversity of our seas. Before we take action on ocean acidification, we will collaborate with other bodies across the UK to research the effects of higher water temperatures on fish stocks and ecosystems, including impacts for fish disease and aquaculture. We will then look to see how the changes will impact the fishing industry and consider our future planning to address the challenges associated with acidification and higher water temperatures.

Marine heritage

In order to ensure our marine heritage is considered in the scope of climate change adaptation we will work with partner organisations, including heritage agencies, commercial partners and higher education establishments to raise awareness and promote research and collaborative working around data collection and sharing. With the correct data, this will then allow us to establish the baseline state of our underwater historic environment and consider the potential changes as a result of climate change. Once we know more about the potential impacts, we will work to ensure that underwater cultural heritage considerations

are included in relevant plans and policies (such as the Wales National Marine Plan) and seek to incorporate environmental monitoring into marine licensing conditions where appropriate.

Current action against other risks

One further risk is noted in the CCRA, for which the UKCCC recommends current action is sustained.

Risks to aquifers and habitats from saltwater intrusion

Aquifers and saltwater intrusion

In Wales, the Conservation of Habitats and Species Regulations 2017 implement the EU 'Habitats Directive' on the Conservation of natural habitats. This legislation provides the legal framework for the protection of habitats and species of European importance in Wales. The UKCCC recognises our efforts to mitigate the potential for saltwater intrusion to harm freshwater aquifers, which is in part being delivered through our work to create compensatory habitat through the requirements of the Habitat Regulations (see above).

Staying healthy

Climate change has the potential to directly impact the health and well-being of Welsh citizens, due to increased temperatures, the risk of flood and other weather extremes. In addition, it has the potential to impact the delivery of health and well-being care.

The UKCCC's CCRA evidence report[15] states there are about 2,000 heat-related deaths per year across the UK and the risk of high temperatures to health is projected to increase as temperatures rise. Conversely, it also states there are between 35,800 and 49,700 cold-related deaths per year across the UK. Climate change is projected to reduce the health risks from cold. However, the number of cold related deaths is projected to decline only slightly due to the effects of an ageing population increasing the number of vulnerable people at risk from high temperatures. Warmer climes in Wales may also see an increase in disease carrying pests, such as ticks and mosquitos.

Flood water may be polluted by sewage, chemicals and/or animal faeces if water has run off fields. Sewage may escape through drains, along with rodents. Polluted flood water can cause a wide range of infectious diseases, including diarrhoeal disease. Other risks include injuries, drowning, contact with chemicals, being stranded, having no power and no clean water. Not having the means to recover from flooding events can also impact adversely on mental health and well-being.

For those particularly reliant on rain for their livelihoods, a lack of rain can cause financial hardship, and mental health problems as a consequence. Farming communities may be most significantly impacted – with crop and livestock losses leading to loss of income and an increase in stress and depression. Drought may also lead to increased use of private, unregulated water sources, with risks of infectious disease. Indeed, there are already large numbers of private water supplies in rural Wales putting people at risk from prolonged drought, leading to a complete loss of water.

The risks to health and social care delivery are wide in scope. Climate change has the potential to disrupt staff, affect the use of buildings and potentially damage equipment. There are also potential issues around thermal comfort of staff and patients in places of care – including care in the home. Several hospitals, care homes and GP surgeries are thought to be at a greater risk of flood due to their geographical positions and projections show this risk will increase. The increased risk of extreme weather events will also make access to care difficult in emergencies.

Urgent Risks

- Risks to habitats and heritage in the coastal zone from sea level rise and loss of natural flood protection
- Risks to passengers from high temperatures on public transport.
- Risks to health and social care delivery from extreme weather.
- Risks to health from changes in air quality.
- Risks to health from vector-borne pathogens.
- Potential benefits to health and well-being from reduced cold.
- Risks to people, communities and buildings from flooding (see 'Safe homes and places').

The gaps

- More work is needed to understand the total risks, and benefits, of increased temperatures to all building types in Wales.
- Research is needed to better understand how people behave in hot weather, as well as the effectiveness of public measures for overheating. In addition, further work is needed to reduce fuel poverty in Wales. Research is also needed to understand the effects of fuel poverty, both now and into the future. Steps need to be put in place to ensure improvements involving insulation also consider effective ventilation in buildings so projected risks from overheating are not exacerbated.
- Research is needed to assess how current action against flood relates to the current risk, including future plans of flood defence spending, implementation of SuDS and to help understand the changing risks to new developments on flood plains.
- More action is needed to consider adaptation needs for the delivery of care at home.
- Improved understanding is needed to assess the connections between climate change and air quality. Long term trend data is needed to consider the impacts on those living chronic respiratory disorders.
- Ongoing surveillance and research of vector borne pathogens is also needed.

Adaptive nature and our rural economy
Protecting our coasts and seas
Staying healthy
Safe homes and places
Protecting our heritage
Successful businesses
Infrastructure and transport

Cross-sector working

If we do not maintain good levels of health, other sectors will likely suffer as a result. Poor health from overheating in the workplace or on public transport will impact our businesses if our workforce is unable to attend their places of work as a result.

Monitoring the potential changes regarding vector borne pathogens will require working with the transport sector in our ports and airports. This also needs consideration in the context of animal health. The factors which may put humans at greater risk, such as increased temperatures, are equally likely to put other animals at risk too.

The health impacts from floods and storm surge may be more strongly felt in our coastal communities as sea levels rise. Maintaining our roads to ensure they are resilient to floods and excessive temperatures will also ensure our emergency services are able to access those in critical need of care.

Our commitments

SH1 Knowledge

Increase understanding of the risk increased temperatures bring to public health and well-being.

The Welsh Government is collaborating with UK level research bodies to inform key agencies in Wales about the risks of increased temperatures to health and well-being. Public Health Wales will issue extreme weather guidance to the public.

Sub Actions	• Increase knowledge of trend data and forecasts to understand the severity of the risk to public health. • Improve collaboration and joined up working to ensure effective sharing of information. • Continue maintenance of heat related guidance in the Public Health Wales (PHW) Extreme Weather Guidance.
Outcome on climate risk	Regularly updated guidance will inform the public and agencies of risk, and responses to extreme weather – reducing risk and vulnerability from weather extremes to the public, such as heatwaves, flooding and drought.
Stakeholders	Public Health Wales Public Health England Welsh Health Boards
Delivery partners	Welsh Government Public Health Wales Welsh Health Boards

SH2 Resilience

Continue tackling fuel poverty through the Welsh Government Warm Homes Programme.

The Welsh Government is driving forward its approach to fuel poverty, with climate risks in mind.

Sub Actions	• 25,000 homes to benefit from the Warm Homes Programme by 2021. • Complete research to evaluate the impacts of Nest and Arbed schemes on health outcomes by 2021. • Develop new proposals to tackle fuel poverty.
Outcome on climate risk	The UK Climate Change Risk Assessment states there are potential benefits to health and wellbeing from reduced cold, but that more needs to be done to reduce fuel poverty in Wales.
Stakeholders	Welsh Health Boards Local Authorities
Delivery partners	The Welsh Government British Gas Local Authorities Public Health Wales

SH3 Capacity	**Update and revise plans and advice in line with research to increase understanding of the future risk extreme weather brings to health and social care delivery.**
The Welsh Government is supporting research to develop evidence, policy and practice to manage climate related risks to health and social care facilities.	
Sub Actions	• Increase our understanding of the risks that long term changes to extreme weather may bring to the delivery of health and social services. • Improve contingency planning.
Outcome on climate risk	Improved understanding of potential future impacts from climate change, alongside improved contingency planning, will reduce risks and vulnerability from weather extremes to the NHS estate.
Stakeholders	Public Health Wales NHS Wales (including emergency services & patient transport) Social Services & Settings Natural Resources Wales Local Authorities
Delivery partners	Public Health Wales NHS Wales (including emergency services & patient transport) Natural Resources Wales Welsh Government

SH4 Capacity	Ensure climate change risk is considered in future policy development to improve air quality in Wales.

Welsh Government will ensure measures taken to reduce air pollution can help mitigate climate change, also resulting in improvements for public health and ecosystems. It is recognised, some measures benefitting climate change have the potential to worsen air quality and vice versa.

Sub Actions	• The Welsh Government is taking an integrated approach to tackling air quality and climate change risk through effective linkages between sector work streams of the Clean Air Programme for Wales and the adaptation plan. • Deliver Clean Air Plan for Wales in 2020. • Support delivery of the National Air Pollution Control Programme (NAPCP), which sets out measures and analysis for how emission reduction commitments can be met across the UK in line with requirements under the National Emission Ceilings Directive (NECD). • Improved and ongoing provision of air quality information and forecasts for the public. • Public Health Wales to provide long term trend data long term health conditions, including chronic respiratory conditions and all-cause mortality outcomes.
Outcome on climate risk	The Climate Change Risk Assessment details risks to air quality due to, for example, potential increases in ground level ozone. Ongoing consideration of climate risk in air quality policy will help reduce this risk, by reducing emissions from activities that contribute to climate change.
Stakeholders	The Welsh Government Devolved Administrations Public Health Wales Natural Resources Wales Local Authorities Transport for Wales
Delivery partners	The Welsh Government The UK Government Devolved Administrations Public Health Wales Natural Resources Wales Local Authorities Transport for Wales

SH5 Knowledge	Increase understanding of the risks from vector borne pathogens.
The Welsh Government is seeking to ensure that their and others' approaches to managing vector borne pathogens takes climate impacts into account.	
Sub Actions	• Continuation of monitoring at ports and airports for mosquitoes. • Raise awareness about Lyme disease amongst health care professionals and the general public. • Increase understanding of the increased risk of vector-borne pathogens.
Outcome on climate risk	Monitoring ports and airports for exotic vectors will help reduce risk to public health from their associated vector borne disease. Improved and ongoing advice to the healthcare profession will ensure we are prepared for increased prevalence, and improved knowledge will help make better decisions to reduce risk in the future.
Stakeholders	Public Health Wales Visit Wales/tourism industry Natural Resources Wales Local Authorities
Delivery partners	Public Health Wales Primary Care leads in Wales (including GPs and associated supply chains) Natural Resources Wales Local Authorities Cardiff Airport Ports Authorities in Wales

Increased temperatures

Extreme weather events, including cold snaps, heat-waves and floods, can have an adverse impact on public health. This is particularly the case for vulnerable people such as the elderly, the very young or people with pre-existing medical conditions. Therefore, Public Health Wales have an Extreme Weather Advice guidance document in place and this is maintained year round. There is also advice available for organisers of outdoor events and for those with child care responsibilities. Public Health Wales are revising their advice to ensure we are prepared for the enhanced risk from climate change in the future, and will be including a new section on how to deal with the health impacts of drought.

Case Study – Public Health Wales (PHW) advice around Extreme Weather Events

When the Met Office forecasts extreme or abnormally cold or hot weather in Wales, Public Health Wales (PHW) considers issuing timely and proportionate advice to the public. This advice – tailored to different audiences and scenarios – is available year-round on the PHW website at: http://www.wales.nhs.uk/sitesplus/888/page/94885.

When extreme weather is forecast, especially if over a prolonged period, proactive communications are issued reminding people where and how they can access this advice.

During the 2017/18 winter period, Public Health Wales (PHW) issued messages on this topic on four separate occasions. It did so using different methods of communication and in January and February 2018, when there was extreme cold weather and considerable snowfall, supplemented these with media interviews for ITV and BBC by Environmental Public Health Team members. On each occasion, standard public health cold weather messages were re-iterated based on PHW guidance and links were made to specific hazards such as falls and carbon monoxide poisoning. In the summer months between June and August 2018, PHW issued advice on how to manage risks associated with extended spells of hot weather, and again referred people to their guidance. As with the extreme cold communications earlier in the year, PHW issued several tweets with simple messages and gave interviews to both BBC and ITV news programmes.

Public Health Wales (PHW) supports the need to consider temperature and health in the context of public transport. However, at present, there is no specific health advice for public transport scenarios. The Welsh Government is working closely with Public Health Wales, given their expertise producing the extreme weather guidance, to develop our policies for transport as part of the development of the new Wales Transport Strategy. This Strategy will be published in late 2020 and will contain our policy interventions to mitigate and adapt to climate change. Policies will be supported by sound evidence that can demonstrate positive benefits to users of our transport system (see 'Resilient Infrastructure and Transport' below). Should they wish to develop guidance, Public Health Wales will advise and contribute as appropriate. Working in conjunction with Public Health Wales and other relevant bodies beyond, Wales will also be encouraged to ensure a consistent approach to this issue across the UK.

The Welsh Government has also begun scoping work for a review of Part L (energy) of the Building Regulations (see 'Safe Homes and Places'). The review will focus on energy efficiency methods, but a key aspect of the work will be the consideration of overheating, to ensure energy efficient home design and planning does not exacerbate the problems of too much warmth. The review will investigate action to reduce overheating in new homes as well as the potential for unintended overheating or poor air quality from external wall insulation. Our intention is that better home design will reduce the incidence rate of overheating in the home into the future.

Health and social care delivery

Our continual review of the Public Health Wales Extreme Weather Guidance will include consideration of the impact of climate change on the delivery of health and social care.

Extreme weather events are reflected in the National Risk Assessment for the NHS in Wales – the NHS and Local Authorities have statutory duties to consider and plan for these risks. In order to plan, a climate change matrix has been developed by NHS Shared Services Partnership – Specialist Estate Services (NWSSP-SES) for the health boards and NHS Trusts to consider in terms of their estate. They need to identify the facilities that are at risk of flooding (or future risk of flooding) and then identify the plans they have in place to address this. These include emergency plans for service disruption and staffing. For new developments, the planning process together with tools like BREEAM will inform decisions in terms of where facilities are being built.

In cases of cold spells and snow storms, Health Boards have emergency procedures in place to respond to the increased demand on health services and issues affecting staff getting into work. We will be reviewing these procedures to reflect the additional future risks brought about by climate change to ensure continued health care delivery into the future.

In terms of overheating, adaptation measures for the existing NHS building stock would principally be the increased uptake of cooling (air-conditioning) but that has a subsequent impact on energy use that we are trying to reduce in line with the public sector's ambition to be carbon neutral by 2030. For new developments the design process will take further climatic predictions into account.

Reduced cold

The UK Committee on Climate Change have clarified that further measures need to be taken in the next 5 years to tackle the large numbers of cold homes and to reduce the effects of cold weather on health, notwithstanding climate change. In Wales, a household is considered to be in fuel poverty if it needs to spend more than 10% of its net income on all household fuel use to maintain a satisfactory heating regime. Latest published data for Wales indicates that in 2016, 291,000 (23%) households were living in fuel poverty[16]. The research also estimates a further 80,000 households in Wales would have been in fuel poverty without the impact of energy efficiency improvements.

The most effective way in which the Welsh Government can tackle fuel poverty is to improve the energy efficiency of homes and we are doing this effectively through the Welsh Government Warm Homes programme. Under the programme, our two schemes Nest and Arbed have been designed to achieve three social, economic and environmental objectives, to reduce the impact on fuel poor households, create green jobs and business opportunities, and reduce greenhouse gas emissions in the domestic sector. Our investment will lever in up to £24m of EU funding, in addition to funding from the UK Energy Company Obligation (ECO). We have committed to installing energy efficiency measures in up to 25,000 homes through the Warm Homes Programme by 2021[vii]. Welsh Government is also continuing to invest in the Fuel Poverty Health Data Linking Project. This project will evaluate the impacts of the Nest and Arbed schemes on health outcomes and broader well-being outcomes – for example, whether there have been improvements to educational attainment through living in a warmer home. Six years of research funding has been committed for this work until March 2021.

The Welsh Government is funding a programme of investment to secure data and analysis needed to inform present and future decisions in relation to domestic housing and energy efficiency, and other fuel poverty measures. The resulting data will inform discussion with stakeholders regarding our future actions on tackling fuel poverty in Wales.

vii https://gweddill.gov.wales/topics/environmentcountryside/energy/efficiency/warm-homes/?lang=en

Air quality

Changes in the climatic system have the potential to influence regional air pollution, including ambient concentration levels and levels of deposition, which affect public and environmental health. In the Climate Change Risk Assessment summary for Wales[viii] the UKCCC highlight the difficulties of getting specific Wales-level data. However, for UK wide data they make the point that higher ambient temperatures can lead to increased ozone concentrations. A changing climate has the potential to make some air quality goals more difficult to achieve in the future.

The Welsh Government intends to consult on the Clean Air Plan for Wales this winter. The aim of the plan is to improve air quality to support public health, biodiversity and natural environment improvements. In developing and delivering the plan, we will ensure integration of air quality and climate change risks where it achieves mutual benefits, including reducing air pollution and climate change impacts.

Replacing earlier legislation (Directive 2001/81/EC), the new NEC Directive requires overall reductions in UK anthropogenic emissions of five damaging air pollutants: nitrogen oxides (NOx), non-methane volatile organic compounds (NMVOCs), sulphur dioxide (SO2), ammonia (NH3) and fine particulate matter (PM2.5), compared with levels in 2005. These pollutants can travel long distances across national borders and affect public health and the natural environment. The Welsh Government set out its plans to help achieve the UK's future emission reduction commitments for 2020 and 2030 within the UK National Air Pollution Control Programme, published on 1 April 2019. Measures which reduce air pollutant emissions will improve air quality even as the climate changes.

To ensure the provision of air quality information, the Welsh Government maintains the 'Air Quality in Wales' website. The site includes data from the region's monitoring sites, and information on related air quality issues. The website helps the public and other users of data determine whether they, or their families, are likely to be at risk from air pollution. If people find they may be at risk, they are referred to health messages corresponding to the highest forecast level of pollution as a guide.

Vector-borne pathogens

In order to be prepared for the increased risk of disease from vector-borne pathogens such as mosquitoes and ticks, we will work to achieve a better understanding of how climate change could exacerbate the issue in Wales. This will include how climate change may affect vectors' ability to establish themselves in Wales, diseases they may carry and spread, as well as treatment requirements and costs.

We will commit to continued support for ongoing surveillance of non-native vectors at key ports and airports in Wales. Port medical officers will work with port health officers to ensure robust surveillance remains in place at existing monitoring sites. Working with the Port Health Expert Panel, Public Health Wales will develop and support delivery of a table top exercise for port authorities to identify potential barriers to delivery of effective mitigation response. In addition, we will research what other action may be needed to understand and survey where such vectors may be entering Wales in the future – consideration will be given to extending surveillance to other potential vector entry sites including both civil and military facilities. Working with Public Health Wales we will consider the evidence of effectiveness of surveillance at distribution centres in England. We will map distribution centres in Wales and advise on the merit of extending surveillance to distribution centres.

viii https://www.theccc.org.uk/wp-content/uploads/2016/07/UK-CCRA-2017-Wales-National-Summary.pdf

With regards to native populations, we will work with experts to ensure where more blue/green infrastructure is used to address issues such as flooding, this does not lead to an increase of pests such as mosquitos, which may use the infrastructure as breeding grounds. We will also investigate where the largest populations of native vectors are, and the options needed to control them. Currently, the risk from mosquitos is considered low. However, to mitigate future risks, Public Health Wales will work with Natural Resources Wales on potential habitats. This will include putting in place effective measures for urban and peri-urban blue and green space to prevent habitats for vectors.

Ticks are already a problem in Wales. Ticks can transmit Lyme disease, and it is understood infection rates could increase as our climate warms. The National Institute for Heath and Care Excellence produces guidance[17] on Lyme disease covers awareness raising for healthcare professionals and information for patients. Furthermore, Public Health Wales has published guidance[18] on what to do to avoid tick bites, and how to deal with any potential infection. In addition to our awareness raising efforts, we will target students and visitors to Wales, including those attending festivals. Public Health Wales will consider how best to communicate messages to these and work with universities to review their communicable disease plans, ensuring actions to support Lyme disease prevention are robust.

Finally, we will review the list of notifiable diseases in the Public Health (Control of Disease) Act 1984. Regulations for the notification of infections in Wales came into force in 2010 and we will consider and consult on whether or not Lyme disease should be added as a notifiable disease.

Current action against other risks

One further risk is included for this section, and highlights the risk to health from poor water quality. This risk was scored as ‘sustain current action’ by the UKCCC.

Risks to health from poor water quality

Water quality

The issue of water quality is managed within the water strategy. The Welsh Government will maintain current policies within the water strategy to maintain high levels of water quality and protect the health of our people. See ‘Safe homes and places’ below for more information about these policies.

Safe homes and places

This chapter focuses on people, in spaces, and the actions we need to take to be resilient from climate change. Our homes, families, communities and friends are all at risk from the impacts of climate change, and the way they're all affected differs depending on where the impacts are felt and how we might adapt. This section has been included to make sure we are taking the human and spatial aspect of the risks from climate change into account. Various forms of inequality has been shown to adversely affect the levels at which communities are impacted by climate change. The IPCC's 1.5 °C Special Report implies urgent, ambitious climate action that puts vulnerable people first, therefore our adaptation actions has been drafted to do just this.

The risks to people and places are wide-ranging and come from all aspects of the impacts we can expect, such as drought, flooding, sea level rise, storms and overheating. We need to think about how climate change might affect those who are often vulnerable to the cold and how this might change as our winters warm. Overheating is a particular problem in our homes, as well as other buildings. While we continue to protect the vulnerable from the cold, we need to ensure that homes are well ventilated to create safe environments during periods of extreme heat.

Projections suggest we should expect drier summers which could mean a greater incidence of water shortages and drought. A lack of water has the potential to harm many aspects of our lives, such as the means to grow food, support our wildlife and quench our thirst. Conversely, too much water comes with a significant risk too. We can now expect to see more rain in the winter and with it, increased likelihood of floods, damaging our homes and buildings and, potentially, flooding our sewers.

The risk of flood will also increase due to the impact climate change has on our oceans. Rising sea levels, along with increase in incidence of storms, has the potential to bring significant damage to the communities along our coastlines, as well as the habitats that line them.

A recent consultation on the 10th edition of Planning Policy Wales recognised climate change as a global challenge, with impacts felt at the local level presenting a significant risk to people, property, infrastructure and natural resources. We need to plan for these impacts, reducing the vulnerability of our natural resources and build an environment which can adapt to climate change. The planning system plays a significant role in managing this risk. Development allowed today will be around for decades to come. The most important decision the planning system makes is to ensure the right developments are built in the right places.

Urgent Risks

- Risks to public water supplies from drought and low river flows.
- Risks of sewer flooding due to heavy rainfall.
- Potential benefits to health and well-being from reduced cold (see 'staying healthy').
- Risks to health and well-being from high temperatures and poor indoor air quality (see 'staying healthy').
- Risks to the viability of coastal communities from sea level rise.
- Risks to people, communities and buildings from flooding.

The gaps

- Work is needed to understand the total risk and benefits of increased temperatures on all types of building in Wales.
- Research is needed to better understand how people behave in hot weather, as well as the effectiveness of public measures.
- More work is needed to reduce the prevalence and impacts of fuel poverty. Steps are needed to ensure improved insulation of housing does not exacerbate the future projected problems of overheating and how homes can be better ventilated.
- Research is needed to assess the current and future risks to different building types and materials from different exposure levels of wind and driving rain, as well as the effectiveness of relevant adaptation.
- There is a need for greater uptake of Sustainable Urban Drainage Systems in new developments.

Adaptive nature and our rural economy

Protecting our coasts and seas

Staying healthy

Safe homes and places

Protecting our heritage

Successful businesses

Infrastructure and transport

Cross-sector working

Ensuring we have safe homes and communities requires input from all sectors. The need to understand the issue of overheating in buildings will have to include hospitals, schools and businesses. In the home, tackling the potential problems of excessive insulation will also be important to our health.

Ensuring we act on surface and sea water flooding means protecting our homes and buildings, but it will also protect our roads and infrastructure, as well as the businesses that operate in our communities.

Any resulting work to understand the impact extreme weather has on building fabric could well be useful in the Historic Environment as we look to new ways to protect our heritage. Additionally, since much of our nature now resides in our urban environments, it is important we consider its role in this section, too.

Our commitments

HP1 Capacity

Ensure the planning system in Wales plays a key role in facilitating sustainable growth and helps build resilience to the impacts of climate change.

The Welsh Government is seeking to ensure that their own and others' approaches to development planning take climate risks into account and encourage climate change adaptation.

Sub Actions	• Develop and publish a new National Development Framework (NDF) for Wales. • Future review of planning policy and guidance on managing flood risk in Technical Advice Note 15. • Increase the use and quality of green infrastructure through nature based solutions.
Outcome on climate risk	An improved planning system will reduce climate risk via better decisions on development sites and greener infrastructure. This will inform a more systemic change in the planning system to factor in climate risks.
Stakeholders	Infrastructure providers Regional economic boards Ports and harbour operators Transport for Wales Natural Resources Wales Cadw
Delivery partners	The Welsh Government Planning authorities Developers

HP2 Resilience

Influence the design of homes and buildings to protect them from the impacts of climate change.

The Welsh Government is seeking to ensure that their own and others' approaches to building design take climate risks into account and encourage climate adaptation.

Sub Actions	• Review part L (energy efficiency) of the Building Regulations to mitigate the risk of overheating. • Ensure opportunities for climate change adaptation are considered in Welsh Government research on decarbonising Wales' housing stock. • Ensure all future programmes to review the building regulations consider the need for climate change adaptation.
Outcome on climate risk	Reviewing building regulations will take into consideration issues such as overheating anticipated from increasing temperatures and reduce risks such as overheating in the home.
Stakeholders	Cadw Architects Planners Registered Social Landlords
Delivery partners	The Welsh Government House builders and developers Cadw Local Authorities

HP3 Capacity	Improve measures to protect homes and communities from the risks of flooding.
The Welsh Government is seeking to ensure that new developments, homes and communities are protected from flood risk, take climate risks into account and encourage climate change adaptation.	
Sub Actions	• Require all future developments in Wales (with the exception of single dwellings with areas less than 100m^2) to be designed and built in accordance with mandatory SuDS standards. • Introduce evidence based long-term planning for waste water and sewerage management, and develop a planning framework for implementation in Wales. • The updated the National Strategy for Flood and Coastal Erosion Risk Management (FCERM) in Wales, will ensure our flood, coastal and planning policies align.
Outcome on climate risk	Implementing SuDS will reduce the otherwise expected increasing risk of flooding to homes and communities, from surface water. Long term planning will need to consider the increase risks posed by climate change on waste water and sewer management. The Welsh Government's renewed FCERM National Strategy will put in place actions to reduce the future expected risk of coastal flooding from rising sea levels.
Stakeholders	Sustainable Drainage Approving Body The UK Government Cadw Natural Resources Wales
Delivery partners	The Welsh Government Housing developers Water companies

HP4 Resilience	Deliver adaptation and capacity building at the community level.
Various funds will be utilised to support community projects which have various benefits to reduce the risks from climate change at a community level.	
Sub Actions	• Continue to support community led climate change adaptation projects (such as those supported by Renew Wales funded by Dormant Accounts Fund administer by the National Community Lottery Fund.
Outcome on climate risk	Awareness of climate change risks and issues will be raised at a community level. Small scale adaptation actions delivered to lower local risks.
Stakeholders	The Welsh Government WCVA
Delivery partners	Lottery Fund National Community Lottery Fund Create Your Space Renew Wales

HP5 Resilience	Work with Public Service Boards to support adaptation and capacity building at the regional level.
The Welsh Government is supporting Public Service Boards to share best practice and work together on climate adaptation on a regional level.	
Sub Actions	• Work with Public Service Boards to develop knowledge of climate risk at the regional level. • Identify regional adaptation options to be made locally and to help cope with the negative impacts of climate change. • Share knowledge and best practice with public bodies and other organisations across Wales.
Outcome on climate risk	• Improved and consistent evidence base to support assessments of local well-being. • Updated Assessment of Local Well-being to take account of climate risk and priority areas for adaptation action – immediate and longer-term (May 2021) • Updated Local Well-being Plans with clear mitigation and adaptation actions (May 2022) • Ongoing assessment of progress against actions, using qualitative and quantitative measures where feasible.
Stakeholders	Cadw Natural Resources Wales UKCCC
Delivery partners	The Welsh Government Public Service Boards

Planning

The Welsh Government's new Planning Policy Wales 10 has been launched and the National Development Framework (NDF) will be published by Welsh Ministers in 2020. The NDF will be the highest level development plan for Wales, meaning it must be taken into account when preparing Local and Strategic Development Plans, and when deciding upon planning applications. It will show and designate nationally significant projects which will be supported by the planning system.

Preparatory work is underway and a Preferred Strategic Option was subject to consultation in summer 2018. It stated "the NDF will ensure that the planning system in Wales plays a key role in facilitating clean growth and decarbonisation and helps build resilience to the impacts of climate change". This provides the hook to enable the NDF to outline actions or measures the planning system can facilitate or deliver in support of our adaptation objectives. The impact of the NDF on adaptation will likely focus on ensuring developments are located appropriately, reflecting the policy set out in Planning Policy Wales.

Any future review of planning policy and guidance on managing flood risk (including an ongoing review of Technical Advice Note (TAN) 15) will give greater focus than is currently the case on the importance of adaptation. The consultation linked to the review of TAN 15 will be launched in 2019/20. This could include the development of a companion guide advising developers, householders and landlords on how homes and premises can be adapted to be resilient to climate change, in a Welsh context.

Urban Green Infrastructure

A national priority of our Natural Resources Policy is to deliver more urban 'Green Infrastructure' through nature-based solutions. Green infrastructure includes all our open spaces and networks of habitats, parks, playing fields, allotments, private gardens, grasslands, ponds, rivers, canals, woodland and hedges. It includes street and garden trees. It can be engineered to form green roofs and walls or sustainable urban drainage. It can also be part of our transport corridors and other links between our built up areas and their surroundings so they 'join up'.

Trees in streets and parks help to cool down urban areas in summer and provide shade for people and buildings. They also help to reduce the pressure on urban drainage systems by absorbing water that would otherwise run off the large areas of impermeable surfaces. Use of the i-Tree Eco system or similar tool can help local authorities quantify the structure and environmental effects of urban trees and calculate their value to society.

Urban green infrastructure provides a wide range of benefits to support adaptation to climate change and to realise those benefits the quality of urban green infrastructure, it is important in particular that it is biodiverse where appropriate. We have established a cross disciplinary working group to drive forward the collective action needed for delivery.

Flooding

Flooding is a key concern from climate change. Current estimates[ix] show over 245,000 properties in Wales are at risk of flooding from rivers, the sea and surface water. The direct impact on people can include injuries, drowning and the stress and anxiety caused by these situations. The UK Committee on Climate Change stated that a higher uptake of Sustainable Drainage Systems (SuDS) is needed in new developments to relieve pressure on the public sewer system. In January 2019 provisions of the Flood and Water Management Act 2010 came into force, requiring all new developments in Wales (with the exception of single dwellings with areas of less than 100m^2) to be designed and built in accordance with the mandatory SuDS standards. In addition to seeking local planning authority approval, developers must seek the technical approval of the local Sustainable Drainage Approving Body (SAB) for the drainage components of a proposed site.

Local Authorities must discharge the SAB function and SABs will be responsible for the approval of SuDS schemes in compliance with statutory SuDS standards and for the adoption and maintenance of these post construction if all conditions are met. The SAB adoption duty under Schedule 3 to the 2010 Act requires the SAB to adopt the SuDS, so long as it is built and functions in accordance with the approved proposals, including any SAB conditions of approval. Post adoption, the SAB has responsibility for maintaining the system.

At current levels of investment, public sewers may not be replaced for up to 700 years. This aging sewerage and drainage infrastructure needs to be surveyed, maintained and upgraded in order to continue to operate effectively and the impact on customer bills now and in the future taken into account. The Welsh Government has agreed with water companies, regulators and Local Authorities to introduce evidence based long term planning for waste water and sewerage management. We have been supporting the UK wide 21st century drainage programme, an industry-led project established to look at how long term planning for sewage and drainage could be implemented, and

ix Source: Flood Risk Assessment Wales (2019) Natural Resources Wales https://naturalresources.wales/evidence-and-data/research-and-reports/reports-evidence-and-data-on-flooding/flood-and-coastal-erosion-risk-in-wales/?lang=en

how it could be technically and evidentially supported. This is a collaborative project with input from regulators, water companies and the Welsh Government, This has developed a planning framework for the production of the first round of drainage and wastewater management plans in Wales by 2023. There is currently no statutory requirement for sewerage undertakers to develop and maintain a drainage and wastewater management plan, and we will consider the need to put these on a statutory footing.

The Welsh Government is collaborating with stakeholders to change the behaviour of consumers, with regards to how our sewers are used. For example, there are educational programmes and campaigns to discourage flushing wet wipes or pouring saturated fats down sinks as these block the sewers, damage the infrastructure and exacerbate sewer flooding. The Welsh Government welcomes the good work done by Welsh Water's 'Let's Stop the Block' campaign and Water UK has now launched its "Fine to Flush" standard to identify which wet wipes can be safely flushed down toilets. The issue of flooding is a key concern to Public Health Wales (PHW). Flood water may be polluted by sewage, chemicals or animal faeces if water has run off fields. Polluted flood water can cause a wide range of infectious diseases, including diarrhoeal disease. Alongside their extreme weather events guidance, PHW provides advice[19] on how to manage the potential, and often real, health impacts of flooding.

The National Strategy for Flood and Coastal Erosion Risk Management (2011) in Wales sets out the Welsh Government's policy to ensure the risks to people and communities from flooding and coastal erosion are effectively managed. As part of the update to the National Strategy which will be published in 2020, a measure will be included for NRW to prepare an updated 'Future Flooding in Wales' report which will use the current number of properties at risk of flooding to help set out future investment need in flood and coastal erosion risk management in Wales.

Cadw has recently published new guidance[x] on ways to establish flood risk for traditional (pre-1919) and historic buildings, and prepare for possible flooding by installing protection 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.

x https://cadw.gov.wales/sites/default/files/2019-07/Flooding%20and%20Historic%20Buildings%20in%20Wales%20Eng.pdf

Case Study – The Barrog Natural Catchment Management Project

Climate Change has resulted in more intense periods of rainfall. The Pitt Report in 2008 recommended innovative ways to combat flooding should be considered as part of any investigation into flood defences improvements. The Barrog Natural Catchment Management Project (RC-RDP SMS Award: £299,728) is a project, led by Coed Cymru Cyf, bringing together partners from the local farming community, NRW, higher education and local schools to deliver changes in land management practices within the Nant Barrog and Elwy catchments to increase attenuation and minimise flood risks downstream at Llanfair Talhaiarn village. It is intended to manage the risk of flooding through natural land based interventions such as hedge and gully planting, improved management of riverine woodland, woody debris dams and changes to land management which will attenuate run-off and reduce the peak flow on downstream flood defences.

This project also utilises latest research methodologies from NRW and Bangor University coupled with innovative citizen science carried out by local school children to measure highly localised rainfall.

https://naturalresources.wales/media/678879/llanfairthnaturalfrm.pdf

Coastal change

The updated National Strategy for Flood and Coastal Erosion Risk Management sets out our policies and the role of Shoreline Management Plans (SMPs) to manage the threat of coastal change.

The Welsh Government intends to include a measure for Coastal Groups to report annual progress on SMP Action Plans to Welsh Government through the Wales Coastal Group Forum, this is subject to the consultation feedback. More detail on our action for coastal communities is detailed in the 'Protecting our coasts and seas' section above.

Adaptation at the community level

The Welsh Ministers, in exercising the powers conferred on them under the Dormant Bank and Building Society Accounts Act 2008, currently consult and direct Welsh expenditure of funding from dormant back accounts, managed by the BIG Lottery Fund. This helps develop community led and inclusive approaches to address the causes of climate change and build resilience to its impacts, with the aim of encouraging behaviour change to be rolled out to other parts of Wales.

Two programmes are underway which are particularly important to delivering climate change adaptation at the community level – 'Renew Wales' and 'Create Your Space'.

Renew Wales[20] uses a mentoring approach by working with influential peers and people of expertise, to support community projects which might otherwise lack the knowledge needed to deliver successful projects. The organisation has already supported the delivery of hundreds of projects across the country. £600k has been committed from the BIG fund to continue this support until at least March 2020, and projects include efforts to refurbish community hubs to make them resilient to extreme weather and woodland maintenance programmes to protect local biodiversity.

The Create Your Space[21] programme is focussing on six larger-scale projects, having received £2.2m from the dormant account fund. These 7-year projects work closely with communities, businesses, Local Authorities, the third sector and Welsh Government, on initiatives relating to the natural environment. The projects are significant and varying in scope, meaning there are lots of opportunities for good practice knowledge sharing at the practitioner level. The Cwlwm Seiriol project in Anglesey, for example, aims to reconnect local communities with local ecosystems, making them aware of the local environmental issues. The 'Welcome to our woods' group based in Treherbert aims to tackle the issues from unemployment by creating a more diverse, enterprising and resilient local economy based on natural resources, landscape and low carbon products. The Eco-Schools Project (see 'Our strategic actions' above) has also led to the development of a number of community led initiatives in Wales.

Case Study – Rhyl High School SuDS

Using Eco-Schools funding provided by Welsh Government, Rhyl High School, in Denbighshire, is undertaking a project to plant flower and vegetable growing beds and use the opportunity to manage land by increasing water storage, reducing run-off and improving water quality.

The project is also reducing the possibility of localised flooding. The outcomes of the project are as follows:

- 4 raised beds constructed (of an area of 31.4m^2). With average rainfall of 1000mm, it is estimated they could store 31,400 litres of water per annum.
- 1 Poly-tunnel (with water collection) constructed. At 9m^2, the tunnel is able to store 9000 litres.
- 6 planters installed (at an area of 3m^2). Total water storage of 3,000 litres.
- 1 container with 1000 litre water collection capacity installed.

A 100m^2 area was then grassed rather than being concreted. 100,000 litres which would have gone straight to drains will now be stored longer on site. 320 trees were also planted to create a new hedge, at 140m long. Although information on how much water trees absorb varies, mature trees can remove 100 litres per day, whereas saplings take 45 litres per inch diameter of tree per week, so approximately 6.5 litres per day. The trees therefore have the potential to remove 116,800 litres per year.

Adaptation at the regional level

The Well-being of Future Generations (Wales) Act 2015 led to the creation of 19 Public Service Boards (PSBs) across Wales – one for each Local Authority. The purpose of PSBs is to improve the economic, social, environmental and cultural well-being in its area by strengthening joint working across all public services in Wales. Each PSB must prepare and publish a Local Well-being Plan setting out its objectives and the steps it will take to meet them.

PSBs must carry out Well-being Assessments to inform the development of their plans and, in doing so, must pay due regard to the latest Climate Change Risk Assessment. In order to develop best-practice in the actions against climate change taken by PSBs, the Welsh Government will support two PSB projects as pilots, and share the knowledge learned with all PSBs and other public bodies to support regional adaptation work moving forward. The area statements produced by NRW will be an important evidence base to support PSB's developing nature based solutions to climate change risks as well as to help understand and address the risks and impacts upon natural resources and ecosystems at a more local level.

The Gwent Strategic Well-being Advisory Group identified that piecemeal adaptation can often be counterproductive and expensive, and that regional collaboration on climate change adaptation would better enable local delivery of public services. Therefore, a project has been developed to bring five communities together across Gwent to work together and identify adaptation options. The project will lead to the development of narrative and graphical outputs as powerful tools which can then be used by decision makers in taking the steps needed to develop resilient communities.

The Ceredigion PSB has set out a well-being aim to make the area more resilient. Their aim is to 'create environmentally responsible and safe communities that can adapt and respond to the effects of climate change'. To do this they intend to support communities to enhance their relationships with their environments and to help them prepare for extreme weather events. In a first step towards achieving this aim, Ceredigion PSB identified the need to complete a detailed regional climate change impact assessment to outline the areas of risks, as well as the responses, actions and options available to them and their communities.

The Welsh Government commits to working with these and other PSBs to support the adaptation options at the regional level. We will take knowledge and examples of best practice from projects such as these and share them widely, so as to help prepare all regions across Wales for the local effects from climate change that they could expect. We are also working with Local Resilience Forums to look at their role in responding to extreme weather events. See 'Resilient Infrastructure and Transport' below for more information.

Homes and buildings

Wales has 1.4 million homes across a wide range of housing types, including a significant proportion of older buildings. Despite national Building Regulations being introduced in 1965, with local standards in existence since the 1930s, we have some of the oldest and least thermally-efficient building stock in Europe. Nevertheless, new construction offers opportunities to incorporate new energy systems and to implement much higher standards of energy efficiency.

Wales has a slightly higher proportion of solid-wall homes than the UK average, which means more of our housing stock is more expensive to insulate. Around 1 in 5 of our homes is not connected to the gas grid, higher

than the UK as a whole. The energy efficiency of our homes was a key consideration in the consultation for our decarbonisation programme and we recently undertook detailed research into actions to decarbonise the Welsh Housing Stock by 2050. These included research into physical types of housing retrofit activities and consider the risks of potential overheating in buildings retrofitted in the way described.

The 2014 review of Part L (Conservation of Fuel and Power) of the Building Regulations in Wales resulted in aggregate performance improvements to new buildings of 8% for residential and 20% for non-domestic buildings. These improvements led to significant carbon emission and economic efficiency savings from our homes. The review also made improvements to existing buildings undergoing work. However, consultation proposal options for new dwellings of higher standards were not taken forward in the light of a depressed housing market following the 2008 financial crash.

Nevertheless, subject to the timetable for leaving the EU, the 2013 recast of the Energy Performance of Buildings Directive Recast 2010 continues to influence domestic policy and requires implementation of a range of provisions. These include 'nearly zero energy' new buildings by 1 January 2019 (for those owned and occupied by the public sector) and by 1 January 2021 (for all new buildings). The intention now is to develop a set of proposals over the next 12 months which build on the 2014 changes and which take account of current concerns, including issues around adaptation and overheating. We anticipate the proposals to go out to public consultation towards the end of 2019.

Any future programmes to review the Building Regulations will also consider needs for climate change adaptation in the home. This will include action aimed at tackling the risks to building fabric from moisture, wind and driving rain.

Current action against other risks

One further risk is included for this section, and highlights the need to sustain current action on water supply. The risk is scored 'sustain current action' in the UKCCC's evidence report.

Risks to health from poor water quality

Water Strategy

Identifying and mitigating the effects of climate change on water resources in Wales is deeply embedded in the development of Welsh Government policy, the regulation of the industry and planning and investing for the future. For these reasons, the long-term goals of the water sector include continuous adaptation to climate change and reducing the industry's carbon footprint. Unlike parts of England, Wales is not forecast to have a water supply deficit over the next 30 years. (Welsh Water has identified two zones that may fall into deficit, but they are developing a programme of investment to ensure sufficient water resources in these areas are maintained). Policies are in place to safeguard the continuity of public water supplies during droughts and from burst pipes in cold weather. These concerns are kept under review to make sure long-term risks continue to be managed appropriately.

The Water Strategy for Wales sets out our vision and approach to ensuring a resilient, and affordable water supply and environment over the next 25 years. The availability of resilient and affordable water supplies is essential to support health and survival of the people of Wales, the economy (including future growth) and the environment.

Water companies have duties to develop robust plans to ensure effective management, maintenance and development of our water resources and supply systems.

These plans include:

- Water Resource Management Plan (WRMP) every five years to set out how the undertaker intends to maintain the balance between supply and demand for water over the next 25 years. The next plans by Welsh undertakers must be published by 2020
- drought plans setting out how they will continue, during a period of drought, to discharge its duties to supply adequate quantities of wholesome water.

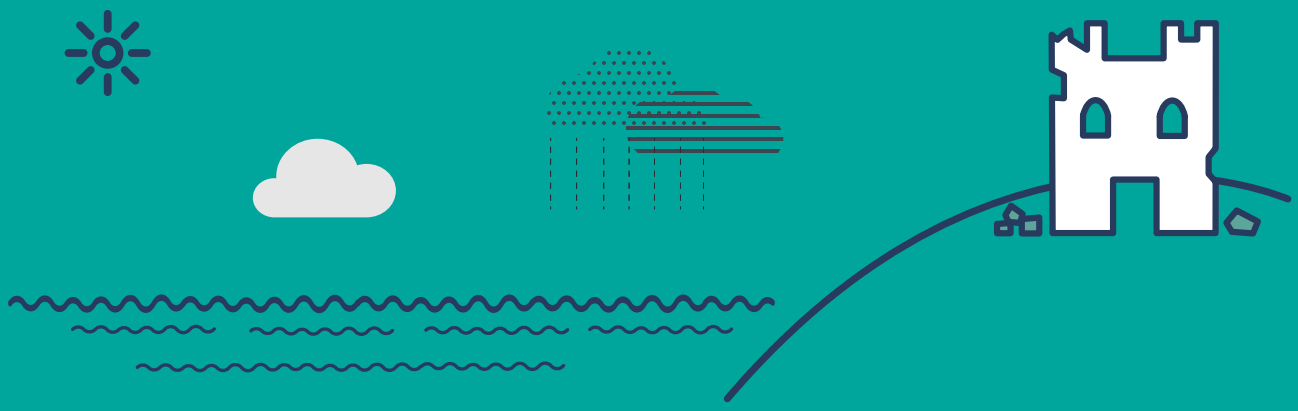
These plans are produced on a 5 yearly cycle and submitted to Ofwat, the economic regulator, for scrutiny. When considering these proposals, Ofwat take into account statutory guidance published by the Welsh Government in the Strategic Priorities Statement[22]. We published this in 2017 and engaged extensively with stakeholders. It puts a strong emphasis on ensuring the resilience of both water resources and sewage and drainage infrastructure. New Welsh Guidelines for WRMPs will be published by 2025.

In addition, NRW has a statutory duty for long-term water resources planning and is a statutory consultee in the development and review of water undertaker drought plans. They review and advise Welsh Ministers on draft plans. During a drought, they regulate water undertakers (a company appointed to provide water services) to ensure that they follow their plans to ensure water supplies are protected for both people and the environment.

Leakage is a high priority issue for customers and can damage the industry's reputation. We have encouraged Ofwat to take a robust line on reducing leakage, and it has set water companies a minimum target to reduce it by 15% by 2025. We expect water companies to continue to innovate and develop expertise in preventing, identifying and repairing leakage more effectively. To reduce water demand, the Welsh Government also participates in the UK Government's Water Efficiency Project. The project includes an initiative to examine the feasibility of a water efficiency labelling scheme for products that use water, along the lines of current energy efficiency labelling schemes for gas and electrical projects.

The Welsh Government is aware of the particular risk faced by those reliant on private water supplies in Wales. In addition to the above, we are part-funding research to increase our understanding of the impacts of climate change on water availability, including private supply. This research will support the UKCCC's development of the next Climate Change Risk Assessment.

Caring for the historic environment



The historic environment is a precious, irreplaceable resource that brings important economic, social, cultural and environmental benefits. It is made up of individual historic features, archaeological sites, historic buildings, parks, gardens, townscapes and landscapes. Some of the most important of these have statutory protection through scheduling, listing or conservation area designation.

The historic environment faces many challenges from climate change and all types of historic asset will be affected. The Historic Environment Group's (HEG) climate change sub group was established to identify and quantity these impacts and to report on potential adaptation responses. Members of the sub group include representatives from Cadw, Natural Resources Wales, the Royal Commission on the Ancient and Historical Monuments of Wales, the National Trust and the Welsh Archaeological Trusts.

The effects of climate change are already being felt in Wales. We are seeing for example the catastrophic impact of coastal erosion at Dinas Dinlle hillfort; increased flooding and storm damage to our historic coastal resorts and low-lying settlements, and wild fires ravaging some of our upland archaeological sites, including Twmbarlwn Mountain near Risca. Some of the impacts, such as those resulting from pests and diseases, predicted change in the distribution of tree species, and the introduction of new crops, particularly in marginal and upland areas, will be more insidious and yet no less profound for our historic and designed landscapes, parks and gardens.

The long, dry summer of 2018 led to many new archaeological discoveries across Wales, in the form of parch marks and crop marks, revealing previously unknown buried sites. Whilst hotter, drier summers may increase opportunities for heritage tourism to support regeneration and economic development, it also carries the risk that increased visitor numbers can, however, harm fragile historic environments, which need to be carefully managed to reduce their vulnerability. It is important therefore that the risks are well understood and well managed to balance competing objectives.

Urgent Risks

- Risks to culturally valued structures and the wider historic environment.
- Risks to building fabric from moisture, wind and driving rain.
- Risks to and opportunities for marine species, fisheries and marine heritage from ocean acidification and higher water temperatures.
- Risks to infrastructure from high river flows and bank erosion.
- Risks to habitats and heritage in the coastal zone from sea-level rise; and loss of natural flood protection.

The gaps

- More research is needed to better quantify the risks and measures needed, regarding the historic built environment.
- More work is needed to allow for dynamic re-adjustment of coastal landforms and habitats, particularly in terms of increased sediment supply and realignment opportunities.
- National level modelling is needed to increase understanding of how the risk of increased river flow may change in the future and how this impacts our bridges.
- A national assessment of bridge scour is needed. It is not known at a national level what bridges are used to carry services.

Adaptive nature and our rural economy
Protecting our coasts and seas
Staying healthy
Safe homes and places
Protecting our heritage
Successful businesses
Infrastructure and transport

Cross-sector working

The things that make up our heritage in Wales can be found in almost every corner of the country. Some of the things we need to protect in our historic environment include the ancient trees protected in our Woodland for Wales plan, and our work in the agricultural sector helps care for buried archaeology, historic landscapes and ancient hedgerows. Work done elsewhere will also protect many of the bridges at risk from bridge scour (see ‘Resilient Infrastructure and Transport’) and the ship-wrecks in our warming seas (see ‘Protecting our coast and seas’).

Cross-sector working is evidently essential when caring for our historic environment. By protecting peatlands to maintain their roles as carbon sinks, we’ll also be protecting a significant amount of archaeological material that lies within them, and our efforts to mitigate the effects of flood in our communities will go some way to protect our historic buildings too.

HE1 Knowledge	Complete and publish the Historic Environment and Climate Change Sector Adaptation Plan
The Historic Environment Group (HEG) climate change sub group will raise awareness of the potential threats and opportunities for the historic environment and seek to secure resources and practical actions to deliver adaptation.	
Sub Actions	• Disseminate and publicise the plan. • Stakeholder engagement with politicians and senior decision-makers to secure resources and practical actions.
Outcome on climate risk	• Raising awareness of the challenges posed by climate change on the historic environment. • Provision of a strategic framework for adaptation actions.
Stakeholders	The Welsh Government Local Authorities Public Service Boards Natural Resources Wales Public bodies in Wales Research bodies Owners of historic assets Front-line Practitioners
Delivery partners	The Historic Environment Group

HE2 Knowledge

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

The delivery partners are seeking to improve understanding of the threats and opportunities through targeted research and investigation.

Sub Actions	• **Spatial mapping** – Establish a working group to develop the enhanced spatial mapping project to identify and prioritise assets at risk and to establish links to monitoring regimes for targeted assets. • **Research** – Use the research priorities identified in the SAP to help inform partner organisations' future research and investigation programmes, including those supported by government funding and grants. • **CHERISH** – Disseminate knowledge gained through the project and use outputs to inform future actions. • **Knowledge exchange** – i) Work with others to seek funding and establish a knowledge exchange group for researchers and practitioners to share ideas, information and good practice and to help identify future research priorities; ii) Continue participation in established UK groups including Fit for the Future and the Historic Environment Adaptation Working Group.
Outcome on climate risk	• Improved evidence base for statutory protection, decision-making and adaptation strategies. • Provision of data and plans for target sites to assist the development of management strategies.
Stakeholders	The Welsh Government Local Authorities Public Service Boards Natural Resources Wales Public bodies in Wales Research bodies Owners of historic assets Front-line Practitioners
Delivery partners	Cadw The Royal Commission on the Ancient and Historical Monuments of Wales The National Trust Welsh Archaeological Trusts Research bodies Historic Environment Adaptation Working Group Fit for the Future network

HE3 Capacity	**Develop the methodologies, tools and guidance needed to build adaptive capacity.**
The HEG climate change sub group is encouraging the development of the resources and materials needed to build the adaptive capacity of organisations and individuals to increase climate resilience of the historic environment.	
Sub Actions	• **Case studies** – develop and publish case studies to identify the key issues, test options for management regimes and inform good practice, e.g. vegetation and earthwork recovery strategies following incidents, such as wild fires or erosion. • **Guidance** – publish and disseminate guidance, e.g. on property flood resilience for traditional and historic buildings. • **Cross-sector working** – to include historic environment considerations in national and local policy statements, plans and codes, including Shoreline Management Plans and CIRIA Code of Practice and guidance on property flood resilience.
Outcome on climate risk	• Increased resilience of historic assets, improved recovery after climate related events and prevention of secondary damage and maladaptation. • Development and implementation of national and local policy statements, plans and codes that increase the resilience of heritage assets.
Stakeholders	Local Authorities Public Service Boards Natural Resources Wales Public bodies in Wales Research bodies Owners of historic assets Practitioners
Delivery partners	The Welsh Government Historic Environment Group Cadw The Royal Commission on the Ancient and Historical Monuments of Wales National Trust Welsh Archaeological Trusts The Historic Environment Adaptation Working Group Fit for the Future network

HP4 Resilience	Increase resilience of the historic environment by implementing actions to respond and adapt to the risks.
The HEG climate change sub group is encouraging the delivery of well-designed adaptation actions on the ground, whether through the programmes and asset management regimes of its member organisations, or through the support they can offer others.	
Sub Actions	• **Pre-application advice** – provide advice on the design and implementation of adaptation proposals, including flood relief schemes, to help ensure potential risks and opportunities for the historic environment are considered. • **Heritage management plans** – provide support for the development of heritage management and adaptation plans, e.g. for heritage tourism businesses. • **Monitoring and recording** – implement programmes and support actions to monitor and record the condition of historic assets at risk.
Outcome on climate risk	Development and implementation of adaptation actions and plans that increase the resilience of heritage assets.
Stakeholders	The Welsh Government Local Authorities Public Service Boards Natural Resources Wales Public bodies in Wales Research bodies Owners of historic assets Practitioners
Delivery partners	Historic Environment Group Cadw Welsh Archaeological Trusts The Royal Commission on the Ancient and Historical Monuments of Wales National Amenity Societies Business Wales Visit Wales

Historic Environment and Climate Change Sector Adaptation Plan

The Historic Environment Group (HEG) climate change sub group has completed the following adaptation risk matrix for the historic environment below. The matrix presents an assessment of potential impacts of climate change on historic assets in different environments.

Linking risks to impacts based on extent, severity, sensitivity and likelihood of occurence.

Risk colour code	High negative	Moderate negative	Small negative	Positive	Limited/ no impact

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								
Marginal and upland								
Marine and coastal								
Rivers, canals, fresh water								
Farmland								
Forestry and woodland								
Industrial landscapes								
Designed landscapes, parks and gardens								

The sub group has gone on to develop a Sector Adaptation Plan (SAP), which will be published by January 2020. It expands upon the risks identified in the CCRA Summary for Wales. It also provides a mechanism for coordinating adaptation by setting out the actions needed to address the anticipated impacts.

The primary aim of the SAP is to encourage collaboration and action across all sectors that will improve understanding, build adaptive capacity and increase the resilience of the historic environment. It will be a living document, reviewed and updated regularly as our understanding of the threats and opportunities for the historic environment develops.

If climate change proceeds as projected, changes that would naturally occur over many hundreds of years will happen much more quickly and are likely to pass through many interim stages. Monitoring, documenting and learning from these various stages will be critical.

Early actions

Key priorities for the HEG climate change sub group in the short-term include raising awareness of the risks to the historic environment and developing the partnerships and resources needed to deliver the actions identified in the SAP (HE1).

Given the need to improve our knowledge and understanding of the impacts of climate change (HE2), early actions will also include establishing a cross-sector working group to provide oversight of an enhanced spatial mapping project. This will build on work already completed by the Royal Commission on the Ancient and Historical Monuments of Wales to map historic assets at risk.

The research priorities identified in the SAP will be used by government funded heritage bodies to inform future work and grant programmes. In some cases this will build on previous work, such as that of the Welsh Archaeological Trusts and their baseline survey of the archaeology of the Welsh coastline and the Arfordir community based programme.

The knowledge gained through this research will be disseminated and used to inform the preparation of guidance, case studies and other resources needed to build the adaptive capacity of organisations and individuals. It will also help underpin the inclusion of historic environment considerations in national and local policy statements, plans and codes, such as the Shoreline Management Plans, as well as local adaptation plans and proposals (HE3).

HEG partners will seek to increase the resilience of the historic environment by supporting others to take action to adapt and respond to the risks, reduce vulnerability and maximize the potential benefits (HE4). Examples will include working with partners to develop and implement site specific heritage management plans and monitoring regimes, as well as providing pre-application advice on the design and implementation of adaptation proposals, including flood relief schemes.

Case Study – CHERISH

CHERISH is a five-year Ireland-Wales project, bringing together four partners across the two nations: the Royal Commission on the Ancient and Historical Monuments of Wales; the Discovery Programme, Ireland; Aberystwyth University: Department of Geography and Earth Sciences; and Geological Survey Ireland. It began in January 2017 and will run until December 2021; and it will receive €4.1 million of EU funds through the Ireland Wales Co-operation Programme 2014-2020.

The key objective of CHERISH is to increase knowledge 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 seas, islands and coast of Wales and Ireland.

The multi-disciplinary project team employs a variety of techniques and methods to study some of the most iconic coastal locations including terrestrial and aerial survey, geophysical survey and seabed mapping, through to paleo-environmental sampling, luminescence dating, excavation and shipwreck monitoring.

The main aims of the project are to:

- **Target data and knowledge gaps to raise awareness of heritage in remote coastal locations.** One example of this has been through the commissioning of 25cm 'leaves off' LiDAR for six Welsh Islands at low tide, providing the first highly-accurate 3D geometric data for the islands and enabling the creation of new archaeological maps of them.
- **Discover, assess, map and monitor heritage on land and beneath the sea and establish new baseline monitoring data and recording standards.** One example of this is the marine mapping of the seabed by Geological Survey Ireland, recording both known and previously unknown shipwrecks. Continued monitoring of a selection of shipwrecks through survey and diving will help understand the impact of ocean acidification and higher temperatures on the long-term stability of underwater cultural heritage.
- **Reconstruct past environments and weather history.** Palaeo-environmental sequencing, luminescence dating and documentary research are being used to establish records of past environments, storminess and extreme weather events providing a long-term context to current and near future risks, and an insight into the nature of climate extremes faced by past communities.

For more information see the CHERISH website – www.cherishproject.eu/en/

Successful Businesses

Wales had an estimated 254,500 enterprises active in 2017, employing circa 1.1 million people. Of these, nearly 39% of people were employed in large enterprises, 12% – medium, 14% – small and the remaining 33% in micro businesses.

Businesses are at risk from climate change due to a number of reasons. Directly, buildings and other sites of work are at risk of damage from extreme weather events such as flooding or high winds. Those on the coast are at risk from rising sea levels and storm surges. Indirectly, our businesses are also threatened by reduced employee productivity due to higher temperatures and infrastructure disruption. The secondary effects of these sorts of disruption go far and wide. Teaching staff not being able to reach their schools during extreme weather events has often lead to school closures, leading to further disruptions for parents and, of course, children. In the construction industry, severe storm can cause delays, leading to financial loss. In some cases, there may be benefits to businesses – the July 2018 heat wave, for example, is understood to have led to a boom of tourism to Wales' many coastal resorts. There are also risks to business supply chains. These can come from several different impacts from climate change and includes the impact of extreme weather damaging the infrastructure networks needed to move goods around Wales, the UK and internationally.

The means by which businesses are able to adapt to these impacts varies significantly. Larger organisations are, more often than not, better enabled to absorb the impacts of staff not reaching their places of work or relatively short term drops in productivity. However, adaptation for smaller organisations can be difficult since priorities often lie elsewhere to ensure viability. In addition, the UK Committee on Climate Change's evidence report suggests that organisations often activate business continuity plans only after they have been impacted by an extreme weather event. This section of the adaptation plan seeks to ensure our businesses are prepared and protected from the impacts of climate change both now and into the future.

Urgent Risks

- Risks to business sites from flooding.
- Risks to businesses from reduced employee productivity, due to infrastructure disruption and higher temperatures in working environments.
- Risks to business from lss of coastal locations and infrastructure.

The gaps

- More research is needed to understand how future spending and uptake of flood defence in Wales protects businesses.
- Further work needs to be done to ensure businesses in Wales have access to the incentives, tools and information needed to be able to adapt to the impacts of climate change.
- More needs to be done to understand the costs and benefits of different adaptation options from the loss of coastal locations for businesses, to provide the means for early and cost effective adaptation.
- Research has been commissioned to provide an evidence base to address risks to businesses from reduced employee productivity, due to infrastructure disruption and higher temperatures in working environments.
- Research is needed to understand the interdependencies between business and infrastructure, types of employment at greater risk and the effectiveness of planned or autonomous adaptation – particularly to thermal discomfort.

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Safe homes and places
Protecting our heritage
Successful business
Infrastructure and transport

Cross-sector working

Wales needs an economy that can support its country through the risks that climate change is projected to bring. Having a strong economy will allow our businesses, big or small, the means to be able to adapt to impacts such as flood and overheating.

These impacts however, are also health concerns. The involvement of expertise in public health is not only needed to provide advice to business for health and safety concerns, but also because much of what we do to adapt will also be of relevance to our hospitals and care homes.

Sustaining our businesses also means making sure we can continue to rely on our world-famous landscapes and heritage as interests to tourism. Furthermore, our utility, digital and transport infrastructure form the veins of our economy. It is essential we recognise the threats to this structure to support and adapt our businesses into the future.

Our commitments

SB1 Knowledge

Do more to understand the risks to businesses from infrastructure disruption and higher working temperatures.

The Welsh Government has identified an information gap as a result of the CCRA at a UK and Welsh level. Research is needed on these climate risks to inform policy and practice in business and industry sectors.

Sub Actions	• Undertake research undertaken to identify industry sectors at risk and potential climate change mitigating options for businesses.
Outcome on climate risk	• Research around the impacts of climate change on businesses will provide the knowledge needed to put in place improved guidance and tools in the future.
Stakeholders	Businesses and Infrastructure Operators Waste and Resources Action Programme Business forums, federations and clubs Economic Ambition Boards
Delivery partners	The Welsh Government Businesses and Infrastructure Operators Carbon Trust Waste and Resources Action Programme

SB2 Capacity

Provide support to businesses to help them adapt to the future risks from climate change.

The Welsh Government will provide adaptation advice to businesses.

Sub Actions	• Revision of Business Wales website, newsletter and twitter content to provide relevant and absorbing advice. • Delivery of workshops to businesses to raise awareness of climate change issues. • Provide 1-2-1 business advice to companies that are moving towards building an adaptation plan.
Outcome on climate risk	• Providing support to businesses will help raise awareness of the risks faced by them in a future climate, give access to advice on adapting to climate change, and lower the risks from climate change to the Welsh economy.
Stakeholders	Businesses and Infrastructure Operators Carbon Trust Waste and Resources Action Programme Energy Savings Trust Business forums, federations and clubs Economic Ambition Boards
Delivery partners	The Welsh Government Business Wales

Research for businesses

At time of writing, there is no specific Welsh (or in-depth UK) research available that identifies specific actions to address business risks and impacts of increased higher temperatures within working environments. Further research is required to better understand key interdependencies between business and infrastructure, the types of employment at greatest risk, and the effectiveness of planned or autonomous adaptation. Research will provide the early steps to understanding these interdependencies, and in the case of higher temperatures, adapting workplace temperature guidance and building standards. This could include, for example, advice on how buildings can be kept in a tolerable range for thermal stress or thermal discomfort reflecting the building's use.

It is proposed that UK-wide research is undertaken to identify specific industry sectors at most risk and potential mitigating actions to minimise business risk and maximise employee health. The Welsh Government will ensure that Wales is comprehensively catered for within research to enable the development of appropriate support.

Support for businesses

Flooding poses a significant risk to business sites, both in terms of damage to assets and in preventing employees from being able to access work premises. Research for the UK (which included a sample of businesses in Wales) suggested that the proportion of private sector organisations saying they have business continuity plans in place for flooding increased from 42% to 58% between 2008 and 2013. However, the report reflected that the smaller the business, the less likely they would have a plan in place.

By providing business advice to a wide range of organisations, the Welsh Government will enable awareness raising within the business management and owners community. Using our Business Wales platform, we aim to provide relevant and absorbing content the website, newsletter and twitter feeds, a range of 1-to-many workshops to raise awareness of the issues, and 1-2-1 business advice to companies that are moving towards building an adaptation plan. This will include a review of our Climate Change Adaptation Business Tool[23], currently targeted towards the tourism sector. The Adaptation Business Tool provides detail of the risks to each subsector within the tourism industry, with useful infographics and suggestions on how to adapt. The tool will be reviewed to expand further into Historic Environment related tourism, and will be considered as a blue-print to helping all other business sectors in a similar way. Welsh Businesses also encourages businesses to adapt to climate change by using the UKCIP's 'BACLIAT' vulnerability assessment tool[24].

Developed with businesses, the tool helps those who need it to find out how climate change poses a risk to them, and points users to further support.

Case Study – Colwyn Bay Waterfront Project

Vibrant and Viable Places was Welsh Government's regeneration programme from 2014 to 2017. The programme invested £124m of capital funding to develop viable and economically sustainable communities across Wales. The programme framework ensured adaptation to the effects of climate change was a key consideration:

> *"Apart from providing a stunning setting to work and live in, many of the raw materials that stimulated the industrial revolution and previous economic growth in Wales came from the natural environment, and that same environment offers new opportunities for tourism, local sustainable food production, carbon storage, and renewable energy generation and, when managed properly,* ***can mitigate the damaging effects of climate change such as flooding.****"*

One good example of this can be found in the regeneration work being completed along the coastline of Colwyn Bay. In addition to the funding from Vibrant and Viable Places, the project attracted funding from the Welsh Government (£13.8m) and ERDF (£2.2m) for the Colwyn Bay coastal defence scheme.

The Colwyn Bay Waterfront Project was initiated to address the condition of the existing coastal defences along the waterfront in Colwyn Bay. The majority of existing defences here dated back to the turn of the 20th century. The decline in beach levels left the defences exposed in many areas and the increased severity and frequency of storm events combined with the threat of climate change posed an ever increasing threat to businesses and infrastructure along the waterfront and the town itself. As the town depended on many tourism businesses for its economy, the decision was made to vastly overhaul the existing flood defences to provide long lasting and effective coastal protection. The programme was also used as an opportunity to enhance tourism by creating a promenade that would attract both local residents and visitors, providing a boost to the local economy.

Mike and Lesley Lewis own the Colbourn Hotel in Colwyn Bay. They said:

> *"It's been a very busy summer, and we have had only positive feedback on the prom from all our guests who have come from all over the world. Many of our guests have already booked to come and stay again next year. We have also noticed guests are staying a little longer this year, which benefits the whole area from tourist attractions, restaurants, pubs, and local shops. It's such a great improvement for Colwyn Bay."*

Current action against other risks

We intend to sustain current action for two further risks in this chapter, as was stated in the UKCCC's evidence report. These risks, and a brief description of our actions against them follows:

Risks to business operations from water scarcity

Risks to business from disruption to supply chains and distribution networks

Water scarcity

Our approach to managing water supply is considered in detail under the 'Safe homes and places' section above. In addition, the Welsh Government published a reformed water abstraction licensing system in 2016 to allow for a more flexible response to shortages and changes in demand for water use. The UKCCC highlight there has been a decline in water use by businesses since 2000. Water abstraction will be monitored to ensure our policies remain effective.

Supply chains and distribution networks

Successful business operation and competition will require knowledge of the risks from climate change, including those risks to supply chains and distribution networks. The UKCCC identified that a lot of guidance already exists for businesses to manage their supply chains, and large companies are already working with suppliers to consider the projected issues, with wider benefits for smaller companies. Autonomous adaptation in the sector will likely continue and will be supported.

Resilient Infrastructure and Transport

Having a resilient infrastructure and transport system is often something we take for granted. Even things as simple as turning on the TV, phoning home or taking the bus to work are all at risk from climate change. However, in the same way, climate change has a way of demonstrating just how critical our infrastructure can be and, ultimately, how important it is that we ensure it runs effectively no matter what.

Climate change has the potential to affect our infrastructure in many ways leading to a multitude of issues. High winds and lightning may damage our energy, digital and transport systems making power cuts more likely without adaptive measures being put in place.

Transport is at risk in a number of ways. Bridge scour (the undermining of bridge foundations) from higher and faster river flows is likely to become a more common phenomenon affecting not just roads, but other bridges such as rail or utility infrastructure. Away from bridges, the foundations of transport networks are considered more likely to be eroded away as slopes and embankments deteriorate from flash floods to the point of danger. We need to do more to understand these issues.

Too much heat is known to 'melt' the tarmac on our roads, cripple ironwork and even lead to power faults. If we are to have a resilient infrastructure network, we need to ensure the consideration of these issues in the future as projections suggest the likelihood of hotter and more frequent heat waves may increase. There may be options to improve, as well as adapt to risks in the coming winters since warmer weather may also mean less issues from cold snaps, such as burst water mains. Nevertheless, the winters will likely bring more rain, and too much water is a problem. Flooding poses risks to all aspects of our infrastructure; this includes transport, energy, digital and communications. The impacts to water supply, drainage and sewers are considered in the safe homes and places section above.

Emergency services can only operate if our communication networks are working and if roads are accessible. Communications networks in turn are reliant on power supplies. We need to consider the impacts that cascading failures across multiple infrastructure services may bring. Many of the impacts from climate change pose risks of health and safety. These dangers include threats from storms damaging utility infrastructure, road and railways, and the problem of overheating in public transport.

Urgent Risks

- Risks of cascading failures from interdependent infrastructure networks.
- Risks to passengers from high temperatures on public transport.
- Risks to bridges and pipelines from high river flows and bank erosion.
- Risks to infrastructure services from coastal flooding and erosion.
- Risks to infrastructure services from river, surface water and groundwater flooding.
- Risks to transport networks from slope and embankment failure.
- Risks to energy, transport and digital infrastructure from high winds and lightning.

The gaps

- More Wales-level evidence needed for both temperature and infrastructure related risks.
- More work is needed to reduce the amount of surface water entering the sewer systems.
- There is a need to improve coordination of surface water management with road maintenance and drainage works.
- National level modelling and research is needed to understand how risk of increased peak river flow may change in the future, alongside a national assessment of bridge scour.
- Further modelling is needed on the increased risk of tree-related faults to energy and rail networks due to projected increases vegetation growth rates.
- There is a need for better understanding around the effects of increased speed and frequency of high winds on infrastructure and transport.

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Cross-sector working

Many of the risks highlighted in this section have important relationships with other sectors. The ways in which our infrastructure networks are connected means that they are often mutually vulnerable. A damaged water supply can lead to floods, impacting transport networks and ultimately leading to delays to our emergency services.

Overheating in public transport needs to be adapted to by those who operate our public transport networks, but the impacts of the risk are health related and collaboration is needed to fully understand the implications. The risks to transport infrastructure needs to be considered from multiple angles also. Many of our bridges are listed as having historical importance. Failing energy and digital infrastructure will impact on just about every aspect of our lives. Our businesses, homes, schools and hospitals are all at risk if we cannot make these resources resilient.

Our commitments

IT1 Knowledge	Improve understanding of the risks from climate change to transport infrastructure in Wales.

The Welsh Government will work with counterparts at UK Government and stakeholders across the UK to fully understand the risks to transport in Wales and consider best approaches to adapting to those risks.

Sub Actions	• The Welsh Government to ensure Wales is comprehensively catered for within research undertaken for transport to enable the development of appropriate support. • Work with Highways England in setting new standards on climate change for road transport. • Review of transport sector case studies to share best practice in adapting to transport related climate change risks in Wales.
Outcome on climate risk	• Improved knowledge of the risks from climate change to transport infrastructure will allow for improved policy to be developed in the future. This will then ensure our transport infrastructure can be adapted to those anticipated risks.
Stakeholders	The Welsh Government Highways England UK Road Liaison Group UK Infrastructure Operators Adaptation Forum Natural Resources Wales Network Rail Local Authorities
Delivery partners	The Welsh Government UK Department for Transport Highways England UK Road Liaison Group Welsh Local Government Association Network Rail Local Authorities

IT2 Capacity

Strengthen our preparedness against multiple risks to interdependent infrastructure networks.

Working with other organisations, the Welsh Government will review and test new policy and practice to prepare Wales against climate change threats which impact multiple infrastructure systems.

Sub Actions	• Complete delivery of pilot exercise to improve emergency response to threats to infrastructure. • Roll out new infrastructure emergency response processes across all Local Resilience Forums. • Work with utility companies specifically to address the risk of a total failure of the UK's national electricity transmission network.
Outcome on climate risk	• Once completed, Wales will have the capacity to respond to acute episodes of weather which impact multiple infrastructure systems, meaning we are able to respond quickly and with as little disruption as possible.
Stakeholders	Businesses and Infrastructure Operators Carbon Trust Waste and Resources Action Programme Energy Savings Trust Business forums, federations and clubs Economic Ambition Boards
Delivery partners	The Welsh Government Local Resilience Forums Distribution Network Operators

IT3 Knowledge

Raise awareness of the level of risk to bridges and pipelines from climate change, and address research gaps to help inform adaptation.

Assessments will be undertaken to understand which bridges and pipelines are most at risk from issues such as bridge scour in order for future improvements to then be considered.

Sub Actions	• Understand the research gaps into erosion and scour, and address the gaps. • Improve understanding of the level of risk to bridges and pipelines across Wales, the bridge owners involved, and the action being taken.
Outcome on climate risk	Completing an assessment of those bridges and pipelines which could be affected by the anticipated increase in river flows will provide the knowledge needed for the Welsh Government and other bodies to consider what action to take against this risk.
Stakeholders	Natural Resources Wales Network Rail Wales Infrastructure Group Local Authorities Utility Companies
Delivery partners	The Welsh Government Network Rail Local Authorities

Researching adaptation in transport infrastructure

Infrastructure across Wales is exposed to a range of climate hazards. Impacts on some assets have the potential to cascade onto others as part of interdependent networks. With electrification of vehicles, the interdependency between transport and electricity is set to rapidly change, particularly with forthcoming automation and optimisation of road transport networks.

Flooding poses the greatest long-term risk to infrastructure performance from climate change, but the growing risks from heat, water scarcity and slope instability caused by severe weather could be significant. The Welsh Government is supporting Highways England in the publication of new Design Manual for Roads and Bridges environment advice notes. The work will include new advice on road drainage and water environment and will help ensure the resilience of our road network from flood.

Transport for Wales

A new organisation has been established in Wales, Transport for Wales. In *Prosperity for All: Economic Action Plan*[25] we detailed the important role Transport for Wales will take, working with our new regional teams, the emerging regional transport authorities and partners to create an integrated public transport network, covering the rail and bus networks. The Economic Action Plan also made clear that the network would focus "on the needs of passengers and it will be safe, reliable, affordable and low carbon". The Welsh Government will call upon Transport for Wales to ensure that new, and improvements to existing transport infrastructure for which they are responsible, will be done in consideration of the risks to transport raised in the latest Climate Change Risk Assessment, including the need to address the problem of overheating, the risks from floods and high winds, and risks from slope and embankment failure.

Case Study – Green Corridors

The European Climate-ADAPT partnership recommends the use of green corridors as a nature based solution to improve biodiversity and animal species dispersal.

The Green Corridor initiative announced in July for the Welsh Government Trunk Road and Motorway network will be investigating measures on the "soft estate" to assist with climate change adaption. This may include planting to contribute to water storage and slope stability as well as improving existing corridors for wildlife to use.

More information regarding the announcement is available by clicking the following link: www,gov.wales/green-corridors-improve-gateways-wales

Bridges

More research is also needed to identify the number of bridges at risk of bridge scour now and in the future, as well as the amount of adaptation underway nationally. This will provide the early steps needed to enable better decisions in the near future (over the next 5 years), especially where measures may be required that have long lead times such as relocating or rerouting bridges. Work on understanding the research gaps is already underway and we are now working with the British Geological Survey to discuss how research into fluvial scour might be taken forward.

Following research, we will work with stakeholders to fully understand how the risk to pipelines and bridges will be mitigated across the sector. We have already mapped approximately 1,000 listed and scheduled bridges, identifying those with statutory protection (see 'Caring for the Historic Environment' above). All of the bridges carrying the strategic road network have been risk-assessed and prioritised for scour repairs in accordance with best practice guidance.

Infrastructure resilience

The wider energy system[26], and the services enabled by it, are heavily interconnected with electricity and communications. Historically systems were less dependent on each other, but with rapid technological development the boundaries between systems are increasingly blurred. Communications and electricity networks are already interdependent with each other. As power systems become smarter, the cyclical dependency between communications and electricity is only set to increase.

Responsibility for energy transmission and distribution is not devolved and is managed by the UK Government's Department for Business, Energy & Industrial Strategy (BEIS). National Grid is responsible for providing a resilient and reliable electricity transmission grid. Distribution Network Operators (DNOs) are required by law to keep distribution power lines free of vegetation and undertake programmes of resilience vegetation management. It is also the responsibility of the owners of infrastructure networks to ensure resilience for surface and sea water flood, and there are positive examples of this.

Working with the Landmark Information Group, Wales and West Utilities have developed an infrastructure vulnerability mapping tool from climate change projections, including sea level rise inundation, new tide-lines, tidal flooding, fluvial flooding for different emission scenarios and probabilities. The tool also considers changes in rates of river bed and bank erosion, potential bridge impacts and transport infrastructure impact. National Grid and all DNOs must publish climate change adaptation reports as a requirement of the UK Governments use of adaptation reporting powers, nevertheless, the CCRA calls for more research to understand the increased risk of tree-related faults to infrastructure. The Welsh Government will call upon the UK Government to ensure the UK energy network is resilient to extreme weather events and to ensure the unique factors and threats of climate change in Wales are a consideration in any research.

The Welsh Government is a member of the Cabinet Office-led Infrastructure, Resilience and Security Working Group (IRSWG) and is working closely with the UK Government, other devolved administrations and Local Resilience Forums in Wales on the existing risk to critical infrastructure. This includes work around the UK Sector Resilience Plans which set out risks to 13 sectors (including energy, transport and emergency services) and measures to improve resilience where necessary. The Welsh Government is currently running a pilot in Dyfed-Powys which brings together responder agencies and utility companies to strengthen preparedness around the various

risks to infrastructure. This pilot will eventually be rolled out to other Local Resilience Forum areas in Wales. The Welsh Government is also working closely with utility companies specifically to address the risk of a total failure of the UK's national electricity transmission network.

Railways

As the owner of most of Britain's railway infrastructure, Network Rail is responsible for much of the maintenance and resilience of the rail network against the impacts and risks from climate change. Weather resilience was a strategic priority of the organisation's 2016 Wales Route Study and, on top of their Weather Resilience and Climate Change Adaptation (WRCCA) plans, Network Rail has also published an adaptation report[27] outlining the risks and actions taken to control them. In Wales, one such action is the Coastal Alert System which forecasts coastal flooding, wave overtopping and toe scour up to 36 hours in advance. A number of other projects are also underway with Network Rail to improve the resilience of the rail network in Wales. Much of these works are being undertaken to respond to a number of impacts including flood risk and risks from slope and embankment failure.

Network Rail is investing £50m on the North Wales Coast under their Railway Upgrade Plan. The project includes enhancements using innovative lightweight polystyrene-blocks to successfully overcome challenging soft ground conditions. Work has also been undertaken to improve the drainage. Network Rail has also launched a Vegetation Management Capability Development Programme to introduce new standards and action to manage line-side growth. The Welsh Government will continue to work with Network Rail and ensure adaptation needs are considered in line with the risks from the CCRA into the future.

KeolisAmey, as Wales' new rail service operator, has agreed a contract for 148 new trains to be provided for a modernised train service in Wales. The trains will go some way towards the problem of overheating on public transport by ensuring all carriages are cooled by air conditioning.

Current action against other risks

There are two further risks against which we will continue to sustain current action, as was recommended by the UKCCC in their evidence report. These are as follows:

Risks to transport, digital and energy infrastructure from extreme heat

Potential benefits to water, transport, digital and energy infrastructure from reduced extreme cold events

Extreme heat and reduced cold weather events

There are a number of policies and procedures in place across our infrastructure networks in the event of extreme heat conditions. The de-rating of power lines is a standard procedure in hot weather to protect energy distribution, which has no short or long term consequences. DNOs have already begun adaptation activities, including taller poles, allowing for line sag on hot days.

The impact of hot weather on the rail network is included in Network Rail's Wales Route Climate Change Adaptation Plan[28]. The Welsh Government accepts the UKCCC's analysis with regards to the benefits to public health outcomes, from reduced cold weather events.

Appendix 1 – Summary of actions and risks

Full detail of the climate change risks to Wales is available in the Wales summary of the UKCCC's Climate Change Risk Assessment Evidence Report[8]. A table of the 'more urgent' risks is given below for reference.

Risk No.	Risk Title	Category/Scoring
Bu. 1	Risks to business sites from flooding	Research Priority
Bu. 2	Risks to business from loss of coastal locations and infrastructure	Research Priority
Bu. 5	Risks to business from reduced employee productivity, due to infrastructure disruption and higher temperatures in working environments	Research Priority
In. 1	Risks of cascading failures from interdependent infrastructure networks	More Action Needed
In. 2	Risks to infrastructure services from river, surface water and groundwater flooding	More Action Needed
In. 3	Risks to infrastructure services from coastal flooding and erosion	More Action Needed
In. 4	Risks of sewer flooding due to heavy rainfall	More Action Needed
In. 5	Risks to bridges and pipelines from high river flows and bank erosion	Research Priority
In. 6	Risks to transport networks from slope and embankment failure	More Action Needed
In. 9	Risks to public water supplies from drought and low river flows	More Action Needed
In. 11	Risks to energy, transport and digital infrastructure from high winds and lightning	Research Priority
Ne. 1	Risks to species and habitats due to inability to response to changing climatic conditions	More Action Needed
Ne. 2	Opportunities from new species colonisations	More Action Needed
Ne. 3	Risks and opportunities from changes in agricultural and forestry productivity and land suitability	Research Priority

Risk No.	Risk Title	Category/Scoring
Ne. 4	Risks to soils from increased seasonal aridity and wetness	More Action Needed
Ne. 5	Risks to natural carbon stores and carbon sequestration	More Action Needed
Ne. 6	Risks to agriculture and wildlife from water scarcity and flooding	More Action Needed
Ne. 7	Risks to freshwater species from higher water temperatures	Research Priority
Ne. 8	Risks of land management practices exacerbating flood risk	More Action Needed
Ne. 12	Risks to habitats and heritage in the coastal zone from sea-level rise; and loss of natural flood protection	More Action Needed
Ne. 13	Improve the condition of the wider marine ecosystem to enable resilience to the impacts of climate change	More Action Needed
	Carry out research to better understand the impact of climate change on marine ecosystems and ecosystem services	Research Priority
Pb.1	Risks to health and wellbeing from high temperatures	Research Priority
Pb.2	Risks to passengers from high temperatures on public transport	Research Priority
Pb.4	Potential benefits to health and wellbeing from reduced cold	More Action Needed
Pb.5	Risks to people, communities and buildings from flooding	Research Priority
Pb.6	Risks to the viability of coastal communities from sea level rise	Research Priority
Pb.7	Risks to building fabric from moisture, wind and driving rain	Research Priority
Pb.8	Risks to culturally valued structures and the wider historic environment	Research Priority
Pb.9	Risks to health and social care delivery from extreme weather	Research Priority
Pb.10	Risks to health from changes in air quality	Research Priority
Pb.11	Risks to health from vector-borne pathogens	Research Priority

The look-up tables below summarise the actions outlined in this annex and which of the above risks the actions aim to mitigate.

No.	Action Title	Bu. 1	Bu. 2	Bu. 3	In.1	In.2	In.3	In.4	In.5	In.6	In.9	In.11	Ne.1	Ne.2	Ne.3	Ne.4	Ne.5	Ne.6	Ne.7	Ne.8	Ne.12	Ne.13	Pb.1	Pb.2	Pb.4	Pb.5	Pb.6	Pb.7	Pb.8	Pb.9	Pb.10	Pb.11
ST1	Review and update our approach to communication for climate change adaptation in Wales																															
ST2	Integrate consideration of climate risks in all future policy and business planning within welsh government and encourage the same in all other public bodies																															
ST3	Assess the risks and opportunities presented by climate change through active engagement in uk research programmes																															
ST4	Support the international community to adapt to climate change at a global level																															
AN1	Restoration of uplands and managing them for biodiversity, carbon, water, flood risk, energy and recreational benefits												X	X	X	X	X	X		X												
AN2	Increased canopy cover and well located woodland for greatest ecosystem service value, climate change adaptation and mitigation												X	X	X	X	X			X												
AN3	Develop resilient ecological networks												X	X					X													
AN4	Protect our natural habitats from the increasing risks associated with invasive non-native species												X	X																		
AN5	Maintain, enhance and restore floodplains and hydrogeological systems to reduce flood risk and improve water quality and quantity												X		X	X	X	X		X												

No.	Action Title	Bu. 1	Bu. 2	Bu. 3	In.1	In.2	In.3	In.4	In.5	In.6	In.9	In.11	Ne.1	Ne.2	Ne.3	Ne.4	Ne.5	Ne.6	Ne.7	Ne.8	Ne.12	Ne.13	Pb.1	Pb.2	Pb.4	Pb.5	Pb.6	Pb.7	Pb.8	Pb.9	Pb.10	Pb.11
AN6	Deliver climate change adaptation through a set of agriculture emission reduction and adaptation measures to support the agriculture industry in responding to climate change												X		X	X	X	X		X												
AN7	Deliver the capability, suitability and climate (csc) programme														X	X	X			X												
MC1	Improve the resilience of habitats and heritage in Wales' coastal zones from the impacts of climate change		X				X						X								X	X					X		X			
MC2	Provide updated policy and guidance on coastal adaptation	X	X				X											X			X					X	X					
MC3	Improve the condition of the wider marine ecosystem to enable resilience to the impacts of climate change												X								X	X										
MC4	Carry out research to better understand the impact of climate change on marine ecosystems, ecosystem services and marine heritage												X								X	X										

No.	Action Title	Bu. 1	Bu. 2	Bu. 3	In.1	In.2	In.3	In.4	In.5	In.6	In.9	In.11	Ne.1	Ne.2	Ne.3	Ne.4	Ne.5	Ne.6	Ne.7	Ne.8	Ne.12	Ne.13	Pb.1	Pb.2	Pb.4	Pb.5	Pb.6	Pb.7	Pb.8	Pb.9	Pb.10	Pb.11
SH1	Increase understanding of the risk increased temperatures bring to health and well-being																						X	X	X					X	X	X
SH2	Continue tackling fuel poverty through the Welsh Government warm homes programme																								X							
SH3	Update and revise plans and advice in line with research to increase understanding of the future risk extreme weather brings to health and social care delivery																									X				X		
SH4	Ensure climate change risk is considered in all future policy development to improve air quality in Wales																						X								X	
SH5	Increase understanding of the risk from vector borne pathogens																															X
HP1	Ensure the planning system in wales plays a key role in facilitating sustainable growth and helps build resilience to the impacts of climate change	X	X		X	X	X	X	X	X	X	X											X			X		X				
HP2	Influence the design of homes and buildings to protect them from the impacts of climate change	X						X															X		X	X	X	X		X		
HP3	Improve measures to protect homes and communities from the risks of flooding	X						X																		X		X				
HP4	Deliver adaptation and capacity building at the community level																						X			X	X					
HP5	Work with public service boards to support adaptation and capacity building at the regional level				X																		X			X	X					

No.	Action Title	Bu. 1	Bu. 2	Bu. 3	In.1	In.2	In.3	In.4	In.5	In.6	In.9	In.11	Ne.1	Ne.2	Ne.3	Ne.4	Ne.5	Ne.6	Ne.7	Ne.8	Ne.12	Ne.13	Pb.1	Pb.2	Pb.4	Pb.5	Pb.6	Pb.7	Pb.8	Pb.9	Pb.10	Pb.11
HE1	Complete and publish the historic environment and climate change sector adaptation plan																				X	X							X			
HE2	Improve understanding of the threats and opportunities for the historic environment from a changing climate								X												X	X							X			
HE3	Develop the methodologies, tools and guidance needed to build adaptive capacity																				X	X							X			
HE4	Increase resilience of the historic environment by implementing actions to respond and adapt to the risks								X												X	X							X			
SB1	Do more to understand the risks to businesses from infrastructure disruption and higher working temperatures	X	X	X																												
SB2	Provide support to businesses to help them adapt to the future risks from climate change	X	X	X																												
IT1	Improve understanding of the risks from climate change to transport infrastructure in Wales				X	X	X		X	X		X												X								
IT2	Strengthen our preparedness against multiple risks to interdependent infrastructure networks				X	X	X					X																				
IT3	Raise awareness of the level of risk to bridges and pipelines from climate change, and address research gaps to help inform adaptation					X			X																			X			

Appendix 2 – Abbreviations

ALC	Agricultural Land Classification
ANC	Area of Natural Constraints
BREEAM	Building Research Establishment Environmental Assessment Method
CCA	Climate Change Act 2008
CCRA	Climate Change Risk Assessment
CCRAER	Climate Change Risk Assessment Evidence Report
CSA	Climate Smart Agriculture
CSC	Capability, Suitability & Climate
DNOs	Distribution Network Operators
ERAMMP	Environment and Rural Affairs Monitoring and Modelling Programme
EU	European Union
FCERM	Flood and Coastal Erosion Risk Management
FEE	Foundation for Environmental Education
GHG	Greenhouse Gas Emissions
INNS	Invasive Non-Native Species
IPCC	Intergovernmental Panel on Climate Change
IPM	Integrated Pest Management
MPA	Marine Protected Areas
MSFD	Marine Strategy Framework Directive
NDF	National Development Framework
NECD	National Emission Ceiling Directive
NFM	Natural Flood Management
NGO	Non-Governmental Organisation
NHCP	National Habitat Creation Programme
NHS	Gwasanaeth Iechyd Gwladol
NRAP	Nature Recovery Action Plan
NRP	Natural Resources Policy
NRW	Cyfoeth Naturiol Cymru
NWSSP-SES	NHS Shared Services Partnership Special Estate Services
OPM	Oak Processionary Moth
PAWS	Plantations on Ancient Woodland Sites
PHW	Public Health Wales
Regions4	Network of Regional Governments for Sustainable Development
SAB	Sustainable Drainage Approving Body
SoNaRRI2	State of Natural Resources Report
SMP	Shoreline Management Plan

SMNR	Sustainable Management of Natural Resources
SSSI	Site of Special Scientific Interest
SuDS	Sustainable Drainage Systems
TAN	Technical Advice Note
UAA	Utilised Agricultural Area
UKCCC	United Kingdom Committee on Climate Change
UKCIP	United Kingdom Climate Impacts Programme
UKCP09/UKCP18	United Kingdom Climate Projections
UKFS	United Kingdom Forest Standards
WGWE	Welsh Government Woodland Estates

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