

Evidence for the third  
UK Climate Change Risk  
Assessment (CCRA3)

# Summary for Wales

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**Image:** Miners Trail, Snowdonia National Park (Unsplash)

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# Summary of climate risks and opportunities for Wales

The Independent Assessment used to help inform the [third UK Climate Change Risk Assessment](#) (CCRA3) assesses 61 risks and opportunities from climate change to Wales, including to business, infrastructure, housing, the natural environment, our health and risks from the impacts of climate change internationally. Risks categorised as “More action needed” and “Further investigation” are more urgent than “Watching brief” and “Sustain current action.” Of these 61 risks and opportunities, more action is needed in Wales now to address 32 of them, with sustaining current action only deemed appropriate in five cases. Of the 61, six issues are deemed to be both a risk and opportunity, four of which are associated with the natural environment and each of these require more action or further investigation. There are also eight opportunities that could arise from climate change in Wales, with half of these also related to the natural environment.

In total, 26 risks from climate change in Wales have increased in urgency score since the previous CCRA five years ago; these are summarised at the start of each section of this report. Only one risk has decreased in urgency score since the previous CCRA. There are also some new risks that were not covered in CCRA2.

In summary, risks in Wales that have a high future magnitude score and where more action is required now to address them, after considering any existing adaptation responses, include the following:

- The impacts of climate change on the natural environment, including terrestrial, freshwater, coastal and marine species, forests and agriculture.
- An increase in the range, quantities and consequences of pests, pathogens and invasive species, negatively affecting terrestrial, freshwater and marine priority habitats species, forestry and agriculture.
- The risk of climate change impacts, especially more frequent flooding and coastal erosion, causing damage to our infrastructure services, including energy, transport, water and Information and Communication Technologies (ICT).
- The impact of extreme temperatures, high winds and lightning on the transport network.
- The impact of increasing high temperatures on people’s health and wellbeing.
- Increased severity and frequency of flooding of homes, communities and businesses.
- The impact on coastal businesses due to sea level rise, coastal flooding and erosion.
- Disruption to the delivery of health and social care services due to a greater frequency of extreme weather.
- Damage to our cultural heritage assets as a result of temperature, precipitation, groundwater and landscape changes.
- Impacts internationally that may affect the UK, such as risks to food availability, safety and security, risks to international law and governance from climate change that will affect the UK, international trade routes, public health and the multiplication of risks across systems and geographies.

The rest of this report outlines what the risks and opportunities are in Wales associated with climate change, their urgency scores, the evidence for this and the benefits for further adaptation action in the next five years.

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**NETHERWOOD SUSTAINABLE FUTURES**  
Sustainability Governance Policy Practice



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# 1. Introduction

## Background on the CCRA3 Technical Report and how it applies in Wales

This report is a summary of the implications for Wales of the evidence for the third and latest UK climate change risk assessment (CCRA3) Technical Report.

The UK Government is required by the Climate Change Act 2008 to conduct a climate change risk assessment every five years to inform the UK National Adaptation Plans for England, Scotland, Northern Ireland and Wales. There are specific requirements which are placed upon Welsh Ministers in the Climate Change Act (2008) Section 80 to produce a report from time to time in response to the CCRA on the Welsh Government's objectives, actions and future priorities regarding the impacts of climate change. In Wales, [Prosperity for All: A Climate Conscious Wales](#) (2019) is the Welsh Government's response to the previous assessment, CCRA2, published in 2017.

This assessment is the third such national risk assessment and the second time the UK Government has asked its independent advisers, the Climate Change Committee to prepare the initial Independent Assessment. The timescale, process and outputs that form the CCRA3 Technical Report are illustrated on the following page.

The process is complex – involving over 450 experts - and has produced a large volume of information which is why a range of materials are provided alongside the CCRA3 Technical Report to summarise the results spatially and thematically. [An Advice Report](#) is also provided as part of the Independent Assessment to give the formal advice from the Committee to the Government, which is then required to publish its own assessment (the CCRA3 Government Report) in 2022.

61 specific risks and opportunities were assessed in detail in the Technical Report and each one given an urgency score. As climate risks and adaptation actions vary across the UK, the urgency scores also vary which is why summaries have been produced for England, Scotland, Wales and Northern Ireland to capture the risk scores and highlight the differences accordingly. The summary highlights the most urgent risks, those which require more action taking and/or require more investigation and the less urgent risks where current action is sufficient or where a watching brief is required.

This Wales Summary is designed to inform the plans of the Welsh Government and its arm's length bodies moving forward, including how its current strategies might need to change as well as how appropriate adaptation measures can be built into its programmes and investments.

Welsh local authorities, public sector bodies and other organisations operating at national, regional and local levels may also find this summary helpful in their own plans for climate resilience. More localised risk assessments may be required, or existing assessments reviewed, in the light of these latest national level findings. It may also be of interest to a much wider audience across the public, private and voluntary sectors where the changing climate is likely to affect plans, projects, investment and operations.

**This report does not provide a detailed assessment of policy, and readers wanting further information about this for each risk should consult the [relevant technical chapter](#). This summary provides signposting showing where you can find this information at the end of each risk. These summaries should also be used as a guide to the overall [CCRA3 Technical Report](#) findings rather than being seen as 'the risk assessment' for each UK nation. They summarise the nature of each risk or opportunity rather than what specific responses should be taken forward.**

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## Broad themes emerging from the analysis:

There a number of broad themes emerging from the analysis in the CCRA3 Technical Report, which indicate areas where progress needs to be made in Wales to address climate risks:

- Current objectives in a wide range of national, sector and issue specific plans in Wales are seen as contributing to climate adaptation. However in many cases they will not, in their current form, be sufficient to manage the scale of the risks described in the report. There is evidence of an adaptation gap between current planning and the scale of action required to manage the risks from climate change in Wales. It will be important to address these gaps over the next five years.
- Work is needed to support decision makers to understand and explore management of climate risks utilising data, scenarios and narratives of future climate change, in order to help them to identify different adaptation pathways for communities, the economy, and the natural environment. This work needs to recognise the importance of cascading risks and the effect of multiple climate impacts.
- Climate adaptation planning needs to be supported by an improved evidence base on climate risk achieved through monitoring, research, risk assessment and strategic planning at local, regional levels supported by national policy and action by the Welsh Government. Stronger collaboration will be needed between government, local authorities, public bodies, the third sector and communities to address the risks set out in the CCRA3 Technical Report.

CCRA3 and its various tools, data sets and web based resources, including this summary, can be used to focus discussion and action in Wales on the above challenges to build climate resilience and deliver climate adaptation.



# At a glance

## The Third UK Climate Change Risk Assessment 2023

Process & Timescale

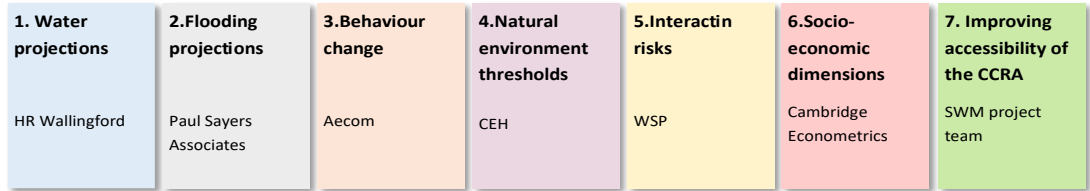
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2018

CCC commissioned Research projects

Spring 2020

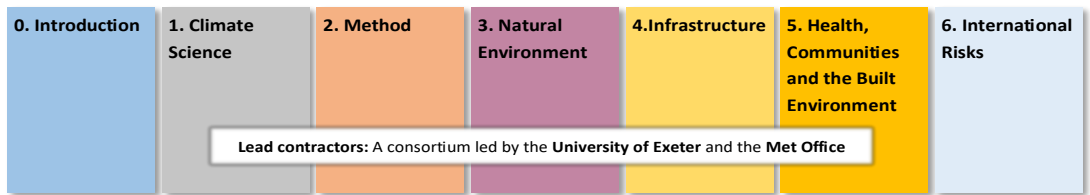
Defra commissions CCC to develop evidence for CCRA3



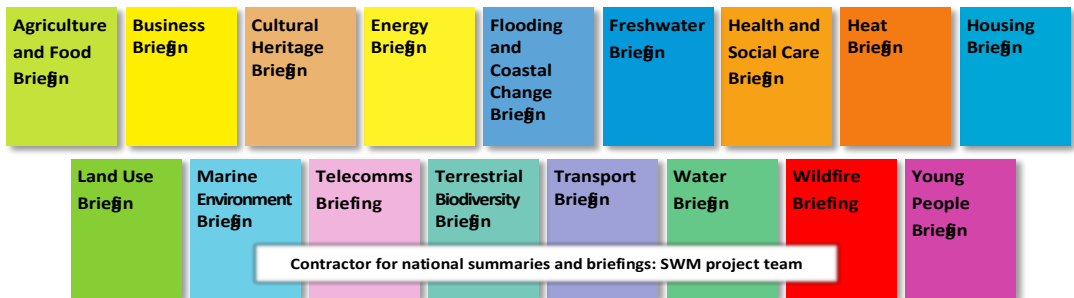
CCRA3 Technical Report

Spring 2021

Research informs Technical Chapters



Translation and communication of CCRA3 Evidence Report



□ Synthesis Report

□ National summaries

□ Topic Briefings

Summer 2021



Suite of CCRA3 Evidence Report documents published

Sent to UK Government and the three Devolved Administrations

CCRA3 published

2022

Updated NAP published

2023



Government reports to Parliament on the latest climate risks to the UK since CCRA2 2017 and the updated plans for managing them

Figure 1: Overview of CCRA3 process, timescale and outputs



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## Assessing Climate Risks and Opportunities for Wales

In the CCRA3 Technical Report, 61 specific risks have been assessed through a three-step urgency scoring process to explore:

- What is the current and future level of risk?
- To what extent is the risk going to be managed?
- Are there benefits of further action in the next five years, over and above what is already planned?

Authors of the Technical Report have been supported to do this through a series of consultations and workshops on risks, and reviewing the draft technical chapters and factsheets with officials and organisations in Wales. Chapter authors have also been supported to reflect the specific contexts in each devolved administration through research and expert judgement commissioned through the Climate Change Committee.<sup>1</sup>

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<sup>1</sup> For Wales, University of Exeter, on behalf of the UK Climate Change Committee, commissioned Netherwood Sustainable Futures to provide specific Welsh policy advice and support to chapter authors on the risk assessment.

Each risk has been categorised by the following urgency scoring:

Category	Description
More action needed	<p>New, stronger or different Government action, whether policies, implementation activities or enabling environment for adaptation – over and above those already planned – are beneficial in the next five years to reduce climate risks or take advantage of opportunities. This will include different responses according to the nature of the risks and the type of adaptation:</p> <ul style="list-style-type: none"> <li>• Addressing current and near-term risks or opportunities with low and no-regret options<sup>2</sup> (implementing activities or building capacity).</li> <li>• Integrating climate change in near-term decisions with a long life-time or lock-in.</li> <li>• Early adaptation for decisions with long lead-times or where early planning is needed as part of adaptive management.</li> </ul>
Further investigation	<p>On the basis of available information, it is not known if more action is needed or not. More evidence is urgently needed to fill significant gaps or reduce the uncertainty in the current level of understanding in order to assess the need for additional action.</p> <p><i>‘Research Priority’ in CCRA2 has been replaced with ‘Further investigation’ in CCRA3. This is because of some confusion following CCRA2 that ‘research priority’ only denoted that more research was needed, when in fact the urgency is to establish the extent to which further adaptation is required.</i></p>
Sustain current action	<p>Current or planned levels of activity are appropriate, but continued implementation of these policies or plans is needed to ensure that the risk or opportunity continues to be managed in the future.</p>
Watching brief	<p>The evidence in these areas should be kept under review, with continuous monitoring of risk levels and adaptation activity (or the potential for opportunities and adaptation) so that further action can be taken if necessary.</p>

<sup>2</sup> [No-regret actions](#) are cost-effective now and under a range of future climate scenarios and do not involve hard trade-offs with other policy objectives. Low-regret actions are relatively low cost and provide relatively large benefits under predicted future climates.

The methodology of the CCRA3 risk assessment process is shown below. This illustrates the depth of analysis undertaken for the 61 risks in CCRA3 Technical Report. More details can be found in the [Method technical chapter](#).

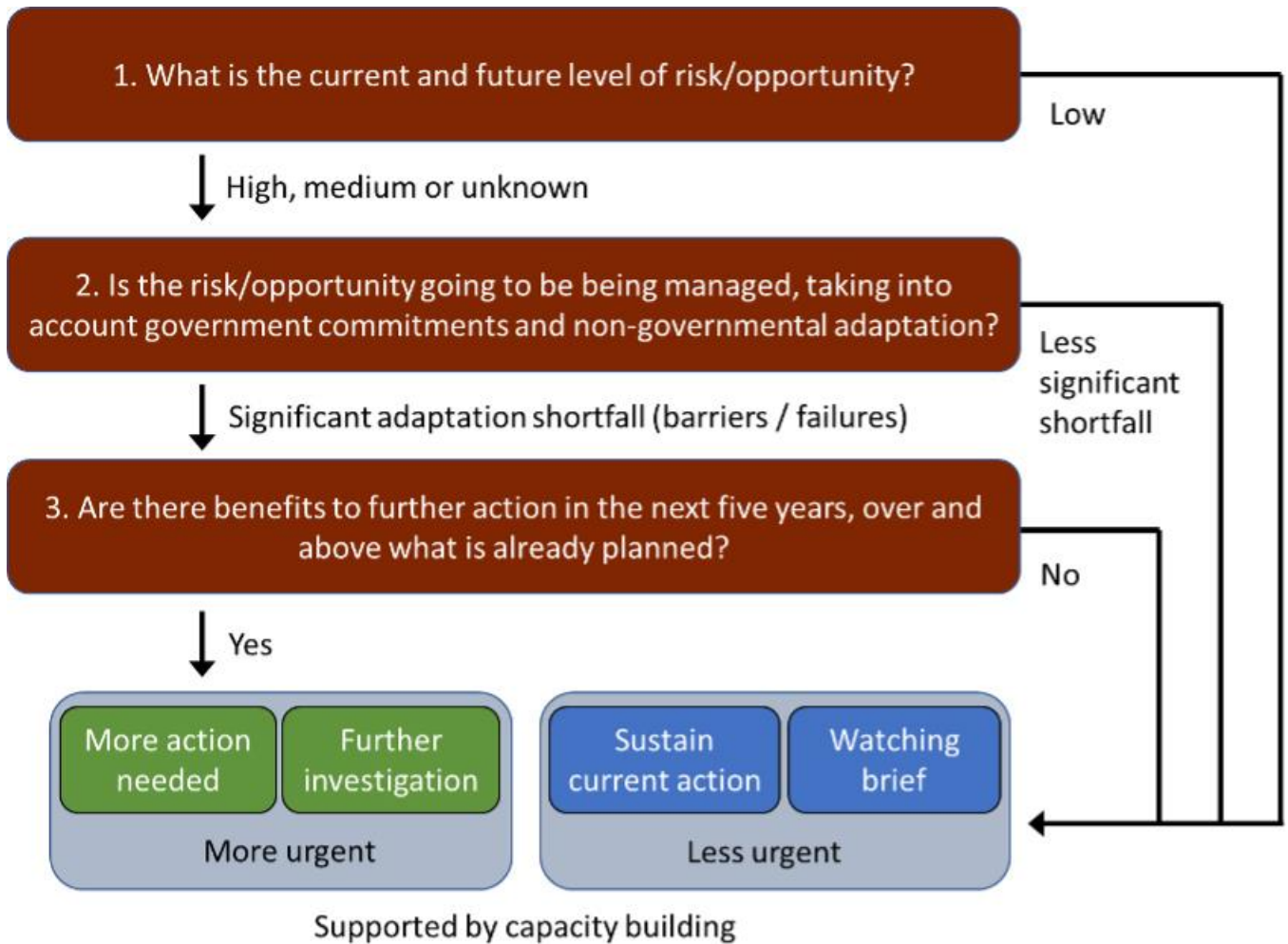


Figure 2: Overall CCRA3 Technical Report Methodology

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## 2. Climate change in Wales

### How is the climate in Wales already changing?

Variable	Observed change in Wales
Average annual temperature	Increase in 0.9°C from mid-1970s to mid-2010s
Annual mean rainfall	Increase in 2.0% from mid-1970s to mid-2010s
Sunshine	Increase in 6.1% from mid-1970s to mid-2010s
Weather extremes	UK-wide increase in extreme heat events  Little evidence yet on changes in extreme rainfall
Sea level rise	UK-wide increase of ~1.4mm per year since 1901 (16cm to date)

#### Temperature

Across Wales, average land temperature in the decade 2010-2019 was 0.9°C warmer than in the period of mid 1970s to mid-2010s, up to 10°C from 9°C. Most notable is the greater incidence of hot summer maximum temperatures in Wales, for example temperatures peaked at 31°C in the 2019 summer heatwave.

#### Rainfall

There has been a small observed increase in annual mean rainfall in recent decades. Between the period of mid 1970s to mid-2010s and 2010-2019 there was an increase of 2%, from an average of 1,402mm per year to 1,430mm per year.

#### Sunshine hours

A clear trend is emerging for increasing sunshine hours for all parts of the UK including Wales, where there was a 6.1% increase in average sunshine hours from the period of mid 1970s to mid-2010s to 2010-2019. Spring 2020 was the sunniest on record for all UK countries in a series stretching back to 1929.

#### Weather extremes

However, the evidence of extreme maximum summer temperatures is becoming clearer, as reflected by how many of the UK's record extreme monthly temperatures have been set in the most recent decade.

#### Sea level rise

A UK-wide sea level index suggests that sea level has risen by between 1.2 and 1.6mm per year since 1901. National variations are projected in future as outlined in the following section.

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## How could the climate change in future?<sup>3</sup>

The changes in climate that we are already experiencing are projected to continue and intensify. In the second half of the century, the amount of change that occurs will depend strongly on how successful we are in reducing greenhouse gas emissions globally.

	2050s	2050s	2080s	2080s
	RCP2.6 (50th percentile)	RCP6.0 (50th percentile)	RCP2.6 (50th percentile)	RCP6.0 (50th percentile)
<b>Annual Temperature</b>	+1.2°C	+1.1°C	+1.3°C	+2.3°C
<b>Summer Rainfall</b>	-15%	-15%	-18%	-26%
<b>Winter Rainfall</b>	+6%	+5%	+7%	+13%
<b>Sea level rise (Cardiff)</b>	22cm	28cm*	43cm	76cm*

### Temperature

Annual temperatures in Wales are expected to rise between approximately 1.2°C by the 2050s and between 1.3 and 2.3°C by the 2080s from a 1981-2000 baseline, based on the methodology set out above and depending on global efforts to reduce greenhouse gas emissions between now and then. Risks associated with rising temperatures, such as more extreme heatwave events causing impacts on people's health and wellbeing, are likely become more prevalent as a result, with their magnitude depending on the degree of change that is experienced.

### Rainfall

There is a difference in expected rainfall trends in future in Wales, depending on the season. In winter, rainfall is expected to increase by approximately 6% by the 2050s and by between 7% to 13% by the 2080s from a 1981-2000 baseline, depending on global efforts to reduce greenhouse gas emissions. This is projected to lead to an increase in the likelihood of flooding of infrastructure, businesses and homes. Conversely, summer rainfall is expected to decrease by approximately 15% by the 2050s and by between 18% to 26% by the 2080s. Periods of water scarcity may become more prevalent under these scenarios, leading to possible implications in agriculture and industry, for example.

### Weather extremes

The frequency and intensity of extreme temperature and rainfall events may also increase in future, depending on global efforts to reduce greenhouse gas emissions. Summers with days above 40°C somewhere in the UK have a return

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<sup>3</sup> These values are taken from the UKCP18 probabilistic projections and represent a central (median) estimate of 30-year average change in each variable from a 1981-2000 baseline. Two emissions scenarios are used; RCP2.6 (roughly equivalent to a global warming +2°C above preindustrial scenario by 2100) and RCP6.0 (roughly equivalent to a global warming +4°C above preindustrial levels by 2100). \*The exception is Sea Level Rise, where the RCP8.5 scenario is used, as for marine projections this is closer to a +4°C global warming scenario. The full likely range of change (i.e. 10 - 90<sup>th</sup> percentile) in each average variable is not shown here but is available from the full UKCP18 database. It is important to note that because these projections show average changes for a 30-year period and only the central estimate, changes in individual years would show a much greater range of change and could be significantly higher (or lower).

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time of 100-300 years at present, but in a high climate change scenario, this could become much more likely, occurring once every 3.5 years by 2100.

In summer, despite overall summer drying, with wet days projected to become less frequent, projections suggest that when it does rain, the rainfall will be more intense.

## Sea level rise

As indicated in the table, using scenarios for Cardiff, sea level is expected to rise by between approximately 22 and 28cm by the 2050s and by approximately 43 to 76cm by the 2080s, compared to a 1981-2000 baseline and depending on global efforts to reduce greenhouse gas emissions. Such rises could lead to an increase in likelihood of associated risks, such as saltwater intrusion of agricultural land and flooding of coastal communities.

The risks associated with these projected changes in Wales are outlined overleaf and are summarised throughout the rest of this document.

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## 3. Summary of the risks and opportunities in Wales

The following table summarises the urgency scores for the 61 risks under five themes from the Technical Report which contains chapters on

- Natural Environment & Assets
- Infrastructure
- Health Communities & the Built Environment
- Business & Industry
- International Dimensions

Each risk is given an urgency score based on the criteria set out on page six of this summary. This urgency score is specific to Wales, and given as follows:

<b>More action needed</b>
<b>Further investigation</b>
<b>Sustain current action</b>
<b>Watching brief</b>

These are clear indicators to Government, agencies, authorities, academics and community leaders in Wales where policy, evidence and action needs to be developed to respond to the risk and opportunities presented in CCRA3.



Natural Environment and Assets			
Risk or Opportunity	Risk number and Receptor	Nature of risk/opportunity	Urgency Score
RISKS	<a href="#">N1. Terrestrial species and habitats</a>	Changing climatic conditions and extreme events, including temperature change, water scarcity, wildfire, flooding, wind, and altered hydrology (including water scarcity, flooding and saline intrusion)	More action needed
RISKS	<a href="#">N2. Terrestrial species and habitats</a>	Pests, pathogens and invasive species	More action needed
RISKS	<a href="#">N4. Soils</a>	Changing climatic conditions, including seasonal aridity and wetness	More action needed
RISKS	<a href="#">N7. Agriculture</a>	Pests, pathogens and invasive species	More action needed
RISKS	<a href="#">N8. Forestry</a>	Pests, pathogens and invasive species	More action needed
RISKS	<a href="#">N10. Aquifers and agricultural land</a>	Sea level rise, saltwater intrusion	Further investigation
RISKS	<a href="#">N11. Freshwater species and habitats</a>	Changing climatic conditions and extreme events, including higher water temperatures, flooding, water scarcity and phenological shifts	More action needed
RISKS	<a href="#">N12. Freshwater species and habitats</a>	Pests, pathogens and invasive species	More action needed
RISKS	<a href="#">N14. Marine species, habitats and fisheries</a>	Changing climatic conditions, including ocean acidification and higher water temperatures	More action needed
RISKS	<a href="#">N16. Marine species and habitats</a>	Pests, pathogens and invasive species	More action needed
RISKS & OPPORTUNITIES	<a href="#">N5. Natural carbon stores, carbon sequestration and greenhouse gas (GHG) emissions</a>	Changing climatic conditions, including temperature change and water scarcity	More action needed
RISKS & OPPORTUNITIES	<a href="#">N6. Agricultural and forestry productivity</a>	Extreme events and changing climatic conditions (including temperature change, water scarcity, wildfire, flooding, coastal erosion, wind)	More action needed
RISKS & OPPORTUNITIES	<a href="#">N17. Coastal species and habitats</a>	Coastal flooding, erosion and climate factors	More action needed
RISKS & OPPORTUNITIES	<a href="#">N18. Landscape character</a>	Climate change	Further investigation
OPPORTUNITIES	<a href="#">N3. Terrestrial species and habitats</a>	New species colonisations	Further investigation
OPPORTUNITIES	<a href="#">N9. Agricultural and forestry productivity</a>	New/alternative species becoming suitable	Further investigation
OPPORTUNITIES	<a href="#">N13. Freshwater species and habitats</a>	New species colonisations	Sustain current action
OPPORTUNITIES	<a href="#">N15. Marine species, habitats and fisheries</a>	Changing climatic conditions	Further investigation

Infrastructure			
Risk or Opportunity	Risk number and Receptor	Nature of risk/opportunity	Urgency Score
RISKS	<a href="#">I1. Infrastructure networks (water, energy, transport, ICT)</a>	Cascading failures	More action needed
RISKS	<a href="#">I2. Infrastructure services</a>	River and surface water flooding	More action needed
RISKS	<a href="#">I3. Infrastructure services</a>	Coastal flooding and erosion	Further investigation
RISKS	<a href="#">I4. Bridges and pipelines</a>	Flooding and erosion	Further investigation
RISKS	<a href="#">I5. Transport networks</a>	Slope and embankment failure	More action needed
RISKS	<a href="#">I6. Hydroelectric generation</a>	Low or high river flows	Further investigation
RISKS	<a href="#">I7. Subterranean and surface infrastructure</a>	Subsidence	Further investigation
RISKS	<a href="#">I8. Public water supplies</a>	Reduced water availability	Sustain current Action
RISKS	<a href="#">I9. Energy generation</a>	Reduced water availability	Watching Brief
RISKS	<a href="#">I10. Energy</a>	High and low temperatures, high winds, lightning	Further investigation
RISKS	<a href="#">I11. Offshore infrastructure</a>	Storms and high waves	Sustain current action
RISKS	<a href="#">I12. Transport</a>	High and low temperatures, high winds, lightning	More action needed
RISKS	<a href="#">I13. Digital</a>	High and low temperatures, high winds, lightning	Further Investigation

Health, Communities and the Built Environment			
Risk or Opportunity	Risk number and Receptor	Nature of risk/opportunity	Urgency Score
RISKS	<a href="#">H1. Health and wellbeing</a>	High temperatures	More action needed
RISKS	<a href="#">H3. People, communities and buildings</a>	Flooding	More action needed
RISKS	<a href="#">H4. Viability of coastal communities</a>	Sea level rise	More action needed
RISKS	<a href="#">H5. Building fabric</a>	Moisture, wind and driving rain	Further investigation
RISKS	<a href="#">H7. Health and wellbeing</a>	Changes in indoor and outdoor air quality	Further investigation
RISKS	<a href="#">H8. Health</a>	Vector-borne disease	Further investigation
RISKS	<a href="#">H9. Food safety and food security</a>	Higher temperatures (food safety) and extreme weather (food security)	Further investigation
RISKS	<a href="#">H10. Health</a>	Poor water quality and household water supply interruptions	Further investigation
RISKS	<a href="#">H11. Cultural heritage</a>	Changes in temperature, precipitation, groundwater, land, ocean and coastal change	More action needed
RISKS	<a href="#">H12. Health and social care delivery</a>	Extreme weather	More action needed
RISKS	<a href="#">H13. Education and prison services</a>	Extreme weather	More action needed
RISKS & OPPORTUNITIES	<a href="#">H6. Household energy demand</a>	Summer and winter temperature changes	More action needed
OPPORTUNITIES	<a href="#">H2. Health and wellbeing</a>	High temperatures	Further investigation

Business and Industry			
Risk or Opportunity	Risk number and Receptor	Nature of risk/opportunity	Urgency Score
RISKS	<a href="#">B1. Flooding of business sites</a>	Increase in flood risk	More action needed
RISKS	<a href="#">B2. Coastal business locations and infrastructure</a>	Coastal flooding, extreme weather, erosion and sea level rise	More action needed
RISKS	<a href="#">B3. Business production processes</a>	Water scarcity	Further investigation
RISKS	<a href="#">B4. Business access to finance, investment and insurance</a>	Extreme weather	Sustain current action
RISKS	<a href="#">B5. Reduced employee productivity in businesses</a>	Infrastructure disruption and higher temperatures in working environments	Further Investigation
RISKS	<a href="#">B6. Disruption to business supply chains and distribution networks</a>	Extreme weather	More action needed
OPPORTUNITIES	<a href="#">B7. Changes in demand for goods and services</a>	Long term climate change	Further investigation

International Dimensions			
Risk or Opportunity	Risk number and Receptor	Nature of risk/opportunity	Urgency Score
RISKS	<a href="#">ID1. Food availability, safety, and quality</a>	Decreasing yields from rising temperatures, water scarcity and ocean changes globally	More action needed
RISKS	<a href="#">ID4. The UK's international interests and responsibilities</a>	International violent conflict resulting from climate change overseas	More action needed
RISKS	<a href="#">ID5. Changes to international governance affecting the UK</a>	Reduced international collective governance due to climate change and responses to it	More action needed
RISKS	<a href="#">ID7. International trade routes</a>	Climate hazards affecting supply chains	More action needed
RISKS	<a href="#">ID8. Risk to the UK Financial Sector from climate change overseas</a>	Climate driven resource governance pressures and financial exposure	Sustain current action
RISKS	<a href="#">ID9. Risks to Public Health from Overseas</a>	Increase in vector borne diseases due to climate change	More action needed
RISKS	<a href="#">ID10. Risk multiplication to the UK</a>	Interactions and cascades of named risks across systems and geographies	More action needed
RISKS AND OPPORTUNITIES	<a href="#">ID3. Migration to the UK and effects on the UK's interests overseas</a>	Climate-related international human mobility	Watching brief
OPPORTUNITIES	<a href="#">ID2. UK food availability and exports</a>	Increases in productivity and areas suitable for agriculture overseas	Watching brief
OPPORTUNITIES	<a href="#">ID6. Increased trade for the UK</a>	Arctic ice melt opening up new trading routes	Watching brief

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## 4. Natural Environment and Natural Assets



*Welsh Uplands, Snowdonia: Unsplash*

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The CCRA3 Technical Report examined the evidence of climate change across 18 identified key risks and opportunities for terrestrial, freshwater, coastal and marine natural environments, as well as for agriculture and forestry and landscapes. The assessment recognises the key principles of the ecosystem approach, including the benefits of the natural environment for human wellbeing and the benefit of nature-based solutions. This section provides:

- A summary and description of each Natural Environment Risk and opportunity.
- Suggestions from CCRA3 Technical Report on the benefits of further adaptation over the next five years.

The Assessment has taken into account the Welsh policy context, its approach to Sustainable Management of Natural Resources through the [Environment \(Wales\) Act 2016](#), including [Natural Resources Policy](#), [State of the Natural Resources Report](#), [Natural Resources Wales Area Statement](#) work, commitments in '[Prosperity for All: A Climate Conscious Wales](#),' individual strategies on habitats and species and discourse in Wales on post-Brexit land management, public goods and payment for ecosystem services. References to the Welsh policy context are made throughout this section.

Most of the risk and opportunity urgency scores related to the natural environment have remained the same as in the CCRA2 Technical Report, but in some cases they have increased, as shown in the table below.

Risk/Opportunity/Risk and Opportunity	Urgency Score CCRA2	Urgency Score CCRA3
N2. Risks to terrestrial species and habitats from pests and pathogens and invasive species	Sustain current action	More action needed
N6. Agricultural and forestry productivity	Research priority	More action needed
N7. Risks to agriculture and forestry from pests and pathogens and invasive species	Sustain current action	More action needed
N14. Risks to marine species, habitats, and fisheries from changing climatic conditions	Research priority	More action needed
N16. Risks to marine species and habitats from pests, pathogens, and invasive species	Sustain current action	More action needed
N18. Risks and opportunities from climate change to natural heritage and landscape character	Watching brief	Further investigation

The Technical Report suggests that it will be essential to embed the concept of nature-based solutions at the heart of climate change adaptation across other sectors including agriculture, flood risk management, water supply, infrastructure and urban planning. The opportunities for co-benefits are high but there are also serious risks if this does not take place. Each risk is explored in detail in the following pages.

# N1. Terrestrial species and habitats

Natural Environment and Assets					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	Department
RISK	N1. Terrestrial species and habitats	Changing climatic conditions and extreme weather events, including temperature change, water scarcity, wildfire, flooding, wind, and altered hydrology (including water scarcity, flooding and saline intrusion)	More action needed	Environment, Energy and Rural Affairs (EERA)	Economy, Skills and Natural Resources (ESNR)

## Summary of risk definition and description

Risks from climate change are species-specific and may lead to changes in species population numbers, timing of life cycle events, species movement and distribution. These can also be affected by habitat availability, wildfires, other climate drivers and interdependencies between species, habitats and ecosystems. The Technical Report has found:

- The magnitude of current and future risks from climate change, both now and in the future is considered to be high due to the number of species adversely affected and likely to be affected.
- Studies on changing bioclimatic suitability for different species groups show impacts from mean or extreme changes in climate, combined with other drivers acting separately or in combination with climate such as land use and habitat loss.
- Lowland landscapes (woodland and wetland) are likely to be affected by hotter, drier summers and upland woodlands by drought.
- While there are already a range of policies and measures in place aimed at facilitating adaptation and reducing the impacts of climate change on terrestrial habitats such as the Natural Resource Management Framework, National Forest Programme and the National Peatland Restoration Programme, there is a lack of evidence of the effectiveness of these measures to date.
- A range of indicators show ongoing declines in biodiversity, which leave species and habitats more vulnerable to climate change impacts. More empirical evidence is needed.
- The policy framework in Devolved Administrations is in place with appropriate conservation objectives, but there is a need for more coherent delivery of widespread landscape-scale adaptation that not only builds ecologically resilient networks, but also ensures wider environmental benefits.
- Examples of habitat restoration in Wales which aim to build resilience to climate change include projects that are part of the [National Peatland Restoration Programme](#) such as the upper Conwy catchment, lowland Mires project and other restoration including the Sands of Life project which will restore over 2,400 hectares of sand dunes across four Special Areas of Conservation on ten separate sites, as well as compensatory saltmarsh creation through the National Habitat Creation Project.

## Benefits of further adaptation action in the next five years

The CCRA3 Technical Report recommends the following approaches to facilitate adaptive management:

- The need for a flexible and integrated approach to managing natural capital, including further realignment of the coast, catchment-scale management strategies, and landscape-scale initiatives to increase habitat extent and improve habitat condition and connectivity

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- Ensuring adaptation is more explicitly accounted for in conservation planning at the site level and more widely.
  - Establishing consistent, long-term monitoring and assessment to inform adaptive management and build a robust evidence base for further action
  - Current plans and targets would benefit from a more specific set of actions for climate change beyond habitat condition, which could include more on planned site alteration to address climate threats (drought, flood, wildfire), spatial planning at small scale (allowing species to move) and large scale networks
  - Ensuring that nature-based, land management solutions are at the heart of Net Zero actions and that other actions that may contribute to our Net Zero carbon target, such as an increasing use of biofuels, do not present an even greater risk of habitat loss or damage.



## N2. Terrestrial species and habitats

Natural Environment and Assets					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	N2. Terrestrial species and habitats	Pests, pathogens and invasive species	More action needed	EERA	ESNR

### Summary of risk definition and description

The CCRA3 Technical Report outlines how risks from pests, pathogens and [invasive, non-native species](#) (INNS) can disrupt key ecosystem functions, threatening individual species or whole habitats and can severely impact a range of ecosystem services including agriculture and forestry, causing economic damage. Pests and pathogens are more difficult and costly to manage once established and widespread across a region. In recent years, warmer winters have had a clear influence on outbreaks and incursions of some pests and pathogens in the UK, and they are increasing (figure 3).

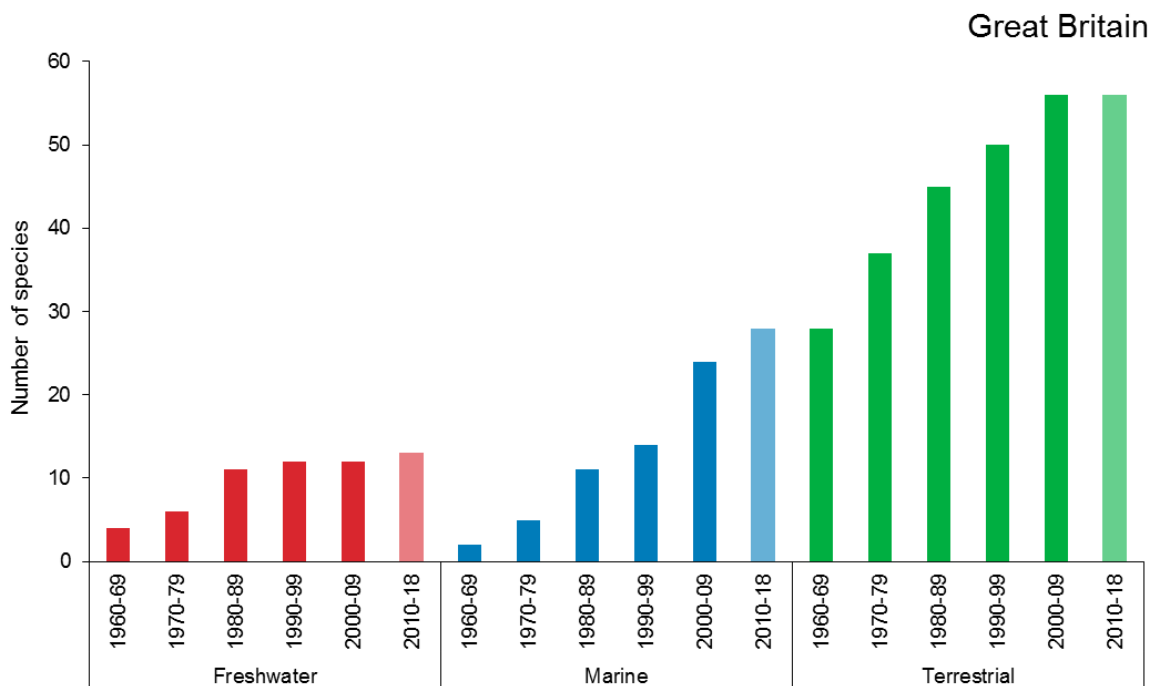


Figure 3: Number of invasive non-native species established across or along 10% or more of the land area or coastline of Great Britain, 1960 to 2018. Note that the last time period is shorter than the other bars (from 2010 to 2018) (taken from 'Natural Environment and Assets' technical chapter).

CCRA3 suggests that this will expand the range of climate suitability for many pest and pathogen species (see [N7](#) and [N8](#)). The [Natural Environment and Assets Chapter](#) highlights research on adapting forests and woodlands in Wales to

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climate change identified the risk of more frequent green spruce aphid attacks on Sitka spruce growth in west, east and south Wales and rhododendron spreading to higher altitudes. The [INNS Group](#) Wales Resilient Ecological Network (WaREN) help to identify INNS priorities and resolve issues relevant to Wales. Gaps in policy and implementation remain, however, including the following.

- Despite strong international and national policy frameworks for managing the risks to terrestrial species and habitats from native pests and pathogens and establishment of INNS, these risks are expected to continue increasing.
- Current risk assessment and management measures provide some adaptive capacity to reduce these risks, but there is a compelling need for enhanced monitoring, surveillance and early response measures to prevent a spread.
- These risk levels could change with further understanding of the specific climate responses and thresholds of high risk pests and pathogens, and the potential change in risk associated with adaptation options.
- The magnitude of current and future risks is considered to be medium for Wales and high by the 2080s under a +4°C at 2100 scenario.
- WaREN was formed to help identify [INNS priorities](#) and resolve issues relevant to Wales. Representatives include Wales Biodiversity Partnership, academia, GB Non-Native Species Secretariat, local authorities, Natural Resources Wales, Public Health Wales, Wales Environment Link, Welsh Government, the Welsh Local Government Association and utility companies.

## Benefits of further adaptation action in the next five years

The CCRA3 Technical Report recommends the following approaches to facilitate adaptive management:

- Further adaptation actions focusing on enhanced monitoring, surveillance and evidence gathering on risk and opportunities adaptation options available for specific INNS species and habitats, and their interconnections, particularly pest and pathogen species - as preventative action can be more effective ecologically and economically.
- Increased horizon scanning for INNS and improved coordination with international pest risk surveillance organisations would help the European Union (EU) to manage risks associated with changes in the post EU exit trade portfolio and projected climate changes.
- More integrated cross-sector policy initiatives, e.g. across agriculture, forestry, natural environment and human health, to implement good practice and share tools and resources
- Assessments of long term lock-in implications of emergency response and planning decisions relating to INNS including contingency planning.

## N3. Terrestrial species and habitats

Natural Environment and Assets					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
OPPORTUNITY	N3. Terrestrial species and habitats	New species colonisations	Further investigation	EERA	ESNR

### Summary of risk definition and description

The analysis in the Technical Report describes how opportunities of climate change will be taxonomy and species specific, with more mobile species likely to be more responsive. Climate change, especially increasing temperatures, can provide the opportunity for increases in populations as well as leading to species moving or expanding their ranges northwards or to higher altitudes. CCRA focuses on available data on bird, butterfly, beetle, insect and plant populations. Species which interact negatively with native species, or alter habitat condition, are considered as an INNS or a pest (see [N2](#)). Others enhance species richness, biodiversity and contribute to adaptation to climate change. CCRA3 suggests that:

- It is likely that climate change will continue to offer opportunities to some, especially mobile, species, which have suitable habitats and food sources in their potential new climate space. Population changes are likely to be species specific.
- There is currently low evidence of the long-term effects of new species movements into or within the UK, together with a lack of specific policy targeted towards realising the opportunities from climate change driven arrivals of new species in terrestrial habitats.
- A number of opportunities across a range of taxa have been identified of species expanding their range and population numbers, which are, at least partly, driven by climate.
- Further investigation is needed to identify species for which climate change would represent an opportunity and to understand the implications of their arrival into new areas or habitats and for conservation planning.
- Opportunities have been identified for species and habitats with warmer mean temperatures lengthening the growing season and enabling trees, grasses and shrubby plants to grow at higher elevations, resulting in a raising of the moorland line. While this change could lead to the expansion of grazing and an increase in grassland productivity, this could be at the expense of semi-natural habitats, such as upland heath.
- It is suggested that broadleaved tree species are likely to be more widespread in central and eastern Wales, which could present an opportunity for increased timber production, carbon sequestration and woodland habitat expansion for conservation.

### Benefits of further adaptation action in the next five years

CCRA3 has the following broad observations:

- No specific adaptation plans are in place, but those for managing species loss (see [N1](#)) are consistent with those needed to support the realisation of associated opportunities.
- Aligning opportunities for new species should be a distinct aspect of habitat creation, restoration connectivity and carbon sequestration and storage (CSS) approaches towards Net Zero.
- The [Natural Environment and Assets Technical Chapter](#) details a range of barriers that will need to be addressed in order to adapt to this risk.

## N4. Soils

Natural Environment and Assets					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	N4. Soils	Changing climatic conditions, including seasonal aridity and wetness	More action needed	EERA	ESNR

### Summary of risk definition and description

The Technical Report outlines how there is already increasing evidence of the negative impacts of climate change on soil resources, often in combination with other factors (notably land use) and that:

- Future climate projections, including UKCP18, provide strong evidence that climate risk factors will increase due to heavier rainfall events (erosion and compaction risks) and increased soil moisture deficits in summer (loss of biota and organic matter etc.). The magnitude of this risk will increase from medium to high in Wales in future.
- Loss of soil resources has important environmental, economic and social consequences and severe degradation of soil quality would be very likely to have long-term, potentially irreversible, implications in the UK. Analysis in Wales has indicated that catchment-wide soil structural degradation is estimated to result in a 10 to 20% reduction in soil water storage capacity, and to contribute up to a 10% increase in short term river flow response to rainfall during the field capacity period.
- Aggregated climate-related pressures (direct or indirect) cover a significant proportion of the UK soils resource with major implications for ecosystem services that soils provide.
- There is an urgent need across the UK for further research and comprehensive monitoring of soils to support development of sustainable soil policy initiatives.
- While there is an increased awareness of this threat, a significant shortfall remains in the adaptation responses, which are not yet commensurate with the level of risk.
- There are increased risks from intense rainfall on soils made up of unconsolidated material from contaminated land, spoil tips, and mine tailings in former mining areas.
- While soil health is included in all of the latest UK national adaptation programmes there are no detailed action plans to integrate and implement these aspirations. A comprehensive soil monitoring strategy is needed to better understand and monitor progress on climate change adaptation in the context of other drivers, together with the effectiveness of different interventions and land management strategies, both locally and at national scale.

Natural Resources Wales [Landscape and a Changing Climate Study](#) (2019) provides a landscape narrative for 14 landscape types in Wales and includes maps and datasets. This focuses on risks to soils from climate change including drying out, desiccation, erosion on all habitat types, landslips and subsidence, silting of rivers, erosion post wildfire and wind erosion from friable soils.

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## Benefits of further adaptation action in the next five years

The CCRA3 Technical Report recommends the following approaches to facilitate adaptive management:

- More comprehensive soil monitoring to help better understand spatial and temporal variability in soil properties and process in the context of both climate and non-climate drivers.
- Better evidence to support soil health and resilience, to be recognised in Welsh Government Soils Policy Evidence Programme (SPEP) and Climate Suitability and Capability Programme (CSCP) initiatives.
- Improved risk management for spoil tips and contaminated land and use of nature-based solutions such as phytoremediation and tree-planting to enhance slope stability.
- Further integration of adaptation and mitigation strategies based upon long-term planning, including woodland expansion and new bioenergy crops.
- Support for land managers to access benchmarking data and advice on how to improve soil health outcomes. The link between climate and land use pressures for soils means that this should be a key focus for further actions, including through improved support for good management practice and through regulation.

## N5. Natural carbon stores, carbon sequestration and GHG emissions

Natural Environment and Assets					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
<b>RISK &amp; OPPORTUNITY</b>	N5. Natural carbon stores, carbon sequestration and GHG emissions	Changing climatic conditions, including temperature change and water scarcity	<b>More action needed</b>	EERA	ESNR

### Summary of risk definition and description

The analysis in the Technical Report outlines the risks and opportunities that occur from the effects of a changing climate on carbon stores and GHG emissions related to Carbon Dioxide (CO<sub>2</sub>), Methane (CH<sub>4</sub>) and Nitrous Oxide (N<sub>2</sub>O) and terrestrial, freshwater, coastal and marine environments, agriculture and forestry. The assessment focuses on role of peatlands, soils, forestry, saltmarsh and blue carbon amongst other factors and provides the following observations on factors which will influence the risk or opportunity.

- Spatial variations in the intrinsic properties of different carbon stores and land use decisions are major factors in influencing stores, sequestration and emissions.
- The magnitude of risk increases from medium at present to high in future, but currently there is only limited inclusion of adaptation planning within carbon and GHG emissions assessments.
- Only limited actions to manage this risk or to maximise the opportunity, considering the effects of climate change, have been developed at a UK or at devolved level. For example, the effects of climate risk factors on agricultural GHG emissions (especially N<sub>2</sub>O) and woodland carbon stocks.
- Marine carbon stocks are not included in the GHG Emissions Inventory (or current Net Zero planning), resulting in general under recognition of their importance for contributing to reduced atmospheric GHG emissions.
- The need for more action is especially urgent given the commitment to reach Net Zero GHG emissions in the coming decades, and opportunities associated with better alignment of climate change adaptation and mitigation strategies.
- The National Peatland Programme aims to ensure all areas of peat supporting semi-natural habitat are brought under sustainable management including plans to restore a minimum of 25% (approximately 5,000 ha) of the most modified areas of peatland back to functional peatland ecosystems. Natural Resources Wales has also undertaken a carbon status assessment of the Welsh Government Woodland Estate.

### Benefits of further adaptation action in the next five years

The CCRA3 Technical Report recommends the following approaches to facilitate adaptive management:

- Improved data on changes in carbon stocks, especially in soils, through enhanced monitoring across diverse land use, management and climate combinations.
- Improved assessment and integration of blue carbon into initiatives for coasts and marine environments, for managed coastal realignment restoration of intertidal areas and seagrass beds.
- Targeted actions to restore degraded carbon stores, particularly peatlands.

- A strategic approach to land use planning, integrating agriculture and forestry, based upon linking net GHG gains with other multiple benefits ([case study 1](#)).
- Research needed to account for climate change risks to carbon stores in UK GHG inventory projections (including appraisal of emission factors, investigation of integrated adaptation and mitigation benefits from nitrogen use efficiency in agriculture and developing a systematic programme of soil carbon monitoring).

## Case Study 1

### Natural Resources Wales Carbon Positive project

Natural Resources Wales calculated their carbon emissions from direct and indirect consumption of energy, goods and services. They were able to set this alongside the carbon sequestering and storage capacity of the land that they managed. They were able to evidence how their organisation was carbon positive with overall emissions from their activities of 41,000 tonnes CO<sub>2</sub> offset by 390,000 tonnes of CO<sub>2</sub> in sequestered and stored carbon. They found that woodland habitats are a main potential source of sequestration, emissions from deep peat soils are significant and that all habitats and their soils play a role in carbon storage.

Source: [Natural Resources Wales](#)





## N6. Agricultural and forestry productivity

Natural Environment and Assets					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
<b>RISK &amp; OPPORTUNITY</b>	N6. Agricultural and forestry productivity	Extreme events and changing climatic conditions (including temperature change, water scarcity, wildfire, flooding, coastal erosion, wind)	<b>More action needed</b>	EERA	ESNR

### Summary of risk definition and description

The CRRA3 Technical Report suggests that there is clear evidence that climate change is modifying the productive capacity of agriculture and forestry and will continue to do so in future, notably for crops, livestock, milk, timber and other fibres, domestic food supply and other commodities. Key findings are that:

- Both forestry and agriculture have a close relationship with climate due to its influence on the viability of different crops or livestock, and on land management activities.
- There is good evidence that weather and climate variations affect both utilised land area (forestry and agriculture) and yields and, in turn, productivity. This includes both risks and opportunities through the multifaceted effects of heat and cold, wetness and drought.
- While opportunities are available, risk magnitude is assessed to increase from medium at present to high in future, with an urgency rating of 'More Action Required' because of the significant lead time to develop and implement actions in the land use sector. These opportunities are not being realised at present, so risks dominate.
- Whilst there are developments in national policies that have the potential to significantly address the gap, these remain in progress and current action is not sufficient to manage the future levels of risks down to low magnitude levels.
- Important knowledge gaps remain which necessitate continuing research on adaptation strategies (e.g., grassland and livestock systems).
- Tree suitability analysis has been conducted focusing on Sitka spruce and sessile oak in Wales which shows a declining suitable area for commercial production due to increased drought risk, although this does not preclude trees being grown for non-production purposes, including for ecosystem services such as flood mitigation, carbon storage, and supporting biodiversity (Bell et al., 2020).
- The analysis provides an indication of future flood risk to the best and most versatile (BMV) agricultural land assets from fluvial and coastal flooding (frequency of 1 in 75 year or greater) with continuation of current adaptation policies (i) coastal (ii) fluvial (figure 4).

Coastal	Baseline (Ha)	2050s 2°C	2080s 2°C	2050s 4°C	2080s 4°C
Assets at significant risk					
BMV land Wales	10,726	21%	37%	37%	65%

Fluvial	Baseline (Ha)	2050s 2°C	2080s 2°C	2050s 4°C	2080s 4°C
Assets at significant risk					
BMV land Wales	52,413	46%	46%	57%	69%

Figure 4: Increased area of current best quality agricultural land at risk of major flooding (1 in 75-year return period) assuming no further adaptation (i) coastal (ii) fluvial.

## Benefits of further adaptation action in the next five years

The CCRA3 Technical Report recommends the following approaches to facilitate adaptive management:

- Trialling and implementation of agricultural drought responses in drought-sensitive areas with local land use contexts such as earlier planting of drought tolerant crops and varieties and soil management responses ([case study 2](#)).
- Forestry schemes to enhance genetic adaptability of key species, in addition to species diversification including increased use of drought-resistant varieties (e.g. from warmer, more southerly locations) in the provenance of seed stock.
- Integration of adaptation pathways with Net Zero pathways in both agriculture and forestry.
- Better coordinated actions between government and the land use sector, recognising agriculture and forestry enterprises as businesses dependent on to capital (including government grants or subsidies), availability of new skills and knowledge, networking and business security.

## Case Study 2: Agricultural Land Classification Capability, Suitability and Climate Programme

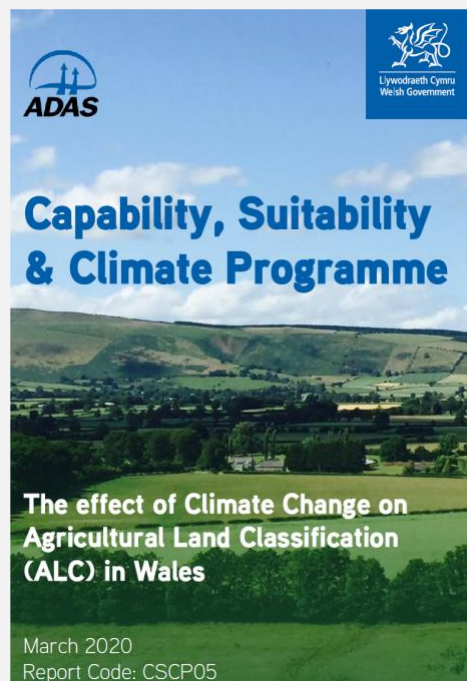
A study funded by Welsh Government and delivered by ADAS in 2020 uses soil, site and climate information to model the potential land suitability for 118 crops under nine projected UKCP18 climate change scenarios, as well as under present day conditions. The project included a variety of crops common to Wales and the UK, as well as crops which are novel to Wales. It included cereals, row crops, horticultural crops, orchard crops, tree crops and specialist crops.

The study explored drought, wetness, field capacity days, seasonality of rainfall and temperature. The study identified clear future risks with greater volumes and intensity of rain in the winter and spring periods and changing timing of access to land. Opportunities were identified as the potential for greater cultivation opportunities and implications for spring cropping.

A key finding from this research is that although drought risk is rather limited at present, it becomes a much stronger risk factor for a significant proportion of the country (Welsh border, Pembrokeshire, Anglesey and North Wales) by the 2050s, and especially by the 2080s.

This provides a good example of research for evidenced based policy and knowledge exchange.

Source: [\*The effect of Climate Change on Agricultural Land Classification \(ALC\) in Wales\*](#)



## N7. Agriculture

Natural Environment and Assets					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	N7. Agriculture	Pests, pathogens and invasive species	More action needed	EERA	ESNR

### Summary of risk definition and description

The CCRA3 Technical Report describes how pests, pathogens and INNS present serious risks to agricultural productivity, for crops and livestock with consequences for livelihoods and businesses, and also suggests that large-scale outbreaks or invasions may have ramifications for food security. It identifies that:

- Future incidence of disease is likely to increasingly diverge from present-day patterns, especially at higher magnitudes of warming, as risks from some species and micro-organisms will increase due to warmer and seasonally wetter conditions, most especially in winter months and others will become more constrained.
- The combined risk factors (climate and non-climate) suggest that the magnitude of this risk is increasing from medium at present to high in the future.
- Current institutional risk assessment procedures provide some adaptive capacity that acts to reduce the risk to a lower level at present and this will also have benefits in reducing risk in the future.
- There is a need for additional urgent action to improve preparedness including improved surveillance, especially in the context of the need for enhanced international co-ordination following EU-exit and associated trade agreements. A key concern is emergent risks and the need for additional contingency planning.

The Natural Resources Wales Area Statements identify opportunities for the development of resilient ecological networks, including the control of INNS, and enable collaborative action on the ground. The [Wales Animal Health and Welfare Framework](#) aims to address increased risks related to pests and pathogens for kept animal health (and associated public health issues) but although climate change is recognised as a key factor, the framework does not make explicit reference to specific climate change risks or adaptation actions to manage these risks. Current strategies do not include consideration of future climate risks including the potential impacts of up to a +4°C at 2100 scenario. In addition, the [INNS Portal](#) was launched as part of the [National Biodiversity Network](#) (NBN) Atlas Wales in November 2018. This holds records and guidance on reporting INNS.

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## Benefits of further adaptation action in the next five years

The CCRA3 Technical Report recommends the following approaches to facilitate adaptive management:

- A more systematic programme of quantitative analysis related to plant breeding, altered planting schedules, chemical and biological control methods, and increased monitoring for new disease threats in order to support disease management plans.
- Improved monitoring of pest and disease levels in Wales' crops and livestock to provide more updated agronomic advice to growers, including best practice guidance on pest and pathogen biosecurity and management strategies.
- Identification of plant and animal strains or breeds having greater natural resistance to inform breeding programmes. Stronger emphasis on Integrated Pest Management rather than over-reliance on chemical controls, as pesticide resistance is an increasing problem.
- Further tightening of plant health legislation in anticipation of increased risks.
- Greater priority given to including climate change within risk assessments, including cross-sectoral initiatives for risk assessment and contingency planning using a range of diverse scenarios.
- Wider public engagement through citizen science initiatives to enhance surveillance.

## N8. Forestry

Natural Environment and Assets					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	N8. Forestry	Pests, pathogens and invasive species	More action needed	EERA	ESNR

### Summary of risk definition and description

The Technical Report describes how pests, pathogens and INNS present serious risks to forest productivity, with consequences for livelihoods and businesses, and for the multiple ecosystem services that forests provide. It identifies that:

- There is increasing evidence of climate change as a factor increasing the rate at which new tree pests and pathogens are introduced.
- High priority pests in the UK Plant Risk Register have been identified with a climate link including emerald ash borer [Agrilus planipennis](#), [Phytophthora ramorum](#) and [Dothistroma](#) needle blight in conifer production, and *P. ramorum*, a fungal-line pathogen particularly in bioclimatic zones with high year-round moisture levels including Wales. [Agrilus biguttatus](#) oak borer beetle, and great spruce bark beetle are also highlighted.
- The combined effect of risk factors (climate and non-climate) indicates the magnitude of this risk is increasing from medium at present to high in the future.
- Existing risk assessment procedures provide some adaptive capacity which acts to reduce residual risk to lower levels at present, but the risk is likely to increase to medium or high levels in future without further actions.
- There is a need for further urgent action to improve preparedness, including enhanced surveillance and horizon scanning to address the increased prospect of emergent risks.
- The scale of future climate change is very likely to mean new threats emerge that challenge existing measures, especially for pathways of higher magnitude of climate change.

The [Woodlands for Wales Strategy](#) (2018) has a strong focus on climate risks including pests and diseases. The plan is to continue to develop strategic approaches for dealing with INNS including muntjac and sika deer, grey squirrel, and rhododendron. Diversification of single-age, single-species woodlands and promotion of responsible sourcing and also prioritised. NRW's Area Statements also address INNS in forestry and woodland, and alongside climate change, INNS is now a cross-cutting theme for the second [Wales State of Natural Resources Report](#).

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## Benefits of further adaptation action in the next five years

The CCRA3 Technical Report recommends the following approaches to facilitate adaptive management:

- Surveillance for emerging risks
- Further modelling of risk reduction measures.
- Further assessment of climate factors in risk assessments being beneficial in early warning.
- Assessing management options for pests and diseases which have become resistant to current pesticides.
- Cross-sectoral initiatives for risk assessment and contingency planning using a range of diverse scenarios.
- Improved biosecurity, especially at ports of entry.
- Changes to plant purchasing and sourcing practices.
- Further investigation of management initiatives to enhance resilience, such as diversification.



## N9. Agricultural and forestry productivity

Natural Environment and Assets					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
OPPORTUNITY	N9. Agricultural and forestry productivity	New/alternative species becoming suitable	Further investigation	EERA	ESNR

### Summary of risk definition and description

CCRA3 suggests that although future climate change, especially warming, will enhance climate suitability for new crops there is limited evidence available to assess the magnitude of potential opportunity. Available evidence is cited on soya, cereal, fruit, wine and other food crop production and implications for forestry. However, there is limited information on the establishment and spread of new crops, especially in a spatial context. Key observations include:

- Based on limited evidence the assessment concludes that the level of opportunity will increase from medium at present to high in the future and has been assessed as a priority for ‘Further Investigation.’
- Recently derived suitability analysis of a wide range of crops in Wales based upon UKCP18 data and bioclimate metrics shows the potential for expansion in some cases. This identifies water availability and drought risk as a key constraint that increase in future.
- There are opportunities for expansion of existing established species such as Douglas fir and sycamore and for fast growing species that are selected for bioenergy sources (e.g. black poplar) although emphasis will also need to be placed on tree species selection matched to the right soil type and other conditions such as soil moisture and exposure.
- There may be opportunities for new species, varieties, and cultivars, together with new cropping combinations (either as mono or inter-crop combinations) and movement of existing species (or varieties and cultivars) between UK countries or regions to others, therefore presenting novel opportunities in that new location.

### Benefits of further adaptation action in the next five years

The Technical Report makes the following observations related to adaptive management:

- Much of the emphasis is of current policy is ‘climate resilience’ related to enhanced production from current systems. More new opportunities to build evidence are needed like the crop suitability analysis for the Capability, Suitability and Climate Programme in Wales.
- More detailed scoping and investigation of opportunities is needed for fruits, vegetables and horticultural crops and its role on enhanced national and local food production.
- Opportunities related to inter-cropping and agro-forestry require further systematic investigation.
- Increased support is needed for adaptive innovations through field or stand trials, new cropping and silviculture systems and outreach activities.

## N10. Aquifers and agricultural land

Natural Environment and Assets					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	N10. Aquifers and agricultural land	Saltwater intrusion	Further investigation	EERA	ESNR

### Summary of risk definition and description

The risk applies to aquifers as well as agricultural land that may use groundwater sources. The analysis in the Technical Report suggests that:

- Future risk to agricultural land from seawater saline intrusion is expected to gradually increase with sea level rise. However, current risk at national scale is assessed as low at present and most likely to remain low in future for all UK nations, although potentially higher for Wales by the 2080s in a +4°C global warming scenario by 2100.
- However, the scale of intrusion risk would significantly increase should a more extreme rate of sea level rise occur (a high++ scenario).
- There is limited evidence for this topic and further research on changes in exposure and vulnerability is recommended, especially as risk is more localised in some areas in Wales. Wales is assessed as needing 'Further Investigation' on this risk.
- The analysis suggests that extreme sea level rises exceeding one metre by 2100 cannot be excluded as a possibility despite their much smaller likelihood based on current evidence.
- In Wales, efforts to mitigate saltwater intrusion are in part delivered through policy related to the Conservation of Habitats and Species Regulations 2017. Evidence gathering on the potential impact of sea level rise on saltwater intrusion could be addressed through [Wales' Flood and Coastal Erosion Risk Management Strategy](#) (2020), [River Basin Management Plans](#) and also [Water Resource Management Plans](#) which are produced by water companies and factor in climate risk to water demand, supply, output, river flows and account for population growth. These cover a 25 year period and are required to consider climate change projections, population growth and new developments.

### Benefits of further adaptation action in the next five years

The CCRA3 Technical Report recommends the following approaches to facilitate adaptive management:

- Continuing current risk management procedures adequate to adapt to the risk for the next five years until CCRA4.
- Liaison with water companies and water users to further investigate spatial and temporal patterns in risk exposure and vulnerability.
- Policy guidance and water abstraction licensing arrangements would need further refinement to incentivise such arrangements as consistent with regular review of regulatory limits.

## N11. Freshwater species and habitats

Natural Environment and Assets					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	N11. Freshwater species and habitats	Changing climatic conditions and extreme events, including higher water temperatures, flooding, water scarcity and phenological shifts	More action needed	EERA	ESNR

### Summary of risk definition and description

Climate change impacts freshwater habitats and species both directly (e.g. species growth and survival responding to temperature change and alterations to flow regimes) and indirectly (e.g. effects on species manifest through their interactions with predators and competitors, or through climate effects on habitat conditions). The CCRA3 Technical Report focuses on impacts related to temperature change, river flows, water quantity and quality, the impact of extreme events, phenology and impacts on species behaviour and abundance. The analysis suggests that:

- Risks from reduced water availability and higher water temperatures will increase the degradation of freshwater habitats and compromise the viability of some freshwater species.
- The magnitude of current and future risks is judged to be medium by the 2050s, under a +2°C at 2100 scenario. This increases to high magnitude for the 2080s +4°C at 2100 scenario.
- This risk has been assessed as needing more action due to the incomplete base of evidence for climate impacts on freshwater ecosystems at present, and the shortfall in adaptation measures that exist currently. Current actions, therefore, are seen to be insufficient to reduce the future magnitude of risks.
- The focus of current strategy is primarily on the impact of reduced water availability and there is very limited evidence of adaptation actions to address risks from high water temperatures. This issue is featuring in NRW work on Area Statements. However, there remains uncertainty about national-level replacements for the Water Framework Directive and River Basin Management Plans following exit from the EU.

### Benefits of further adaptation action in the next five years

The CCRA3 Technical Report recommends the following approaches to facilitate adaptive management:

- More action combined with further investigation on the scale of risk and effectiveness of current measures.
- Adaptation options built into the development and implementation of Environmental Land Management schemes in the UK following exit from the EU which applies from 2023.
- Ensuring that River Basin Management Planning (RBMP) facilitates climate risk management ([insight 1](#)). For Wales this would mean clear proposals and processes to support climate adaptation in [Sustainable Farming and Our Land](#) development and funding mechanisms.

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## Insight 1: River Basin Management Planning in Wales

Natural Resources Wales are required by 2020 guidance to integrate adaptation to climate change into the steps of the River Basin Management Planning (RBMP) process under the 2017 Regulations. They must set out how climate change has been considered in monitoring, assess pressures and choice of measures with preference being given to measures that provide a high level of climate resilience or flexibility.

Current RBMPs for western Wales; Severn and Dee rivers and 11 catchment summaries focus on climate risks to soils, water, trees, biodiversity, water demand, supply and character, particularly focusing on nitrates, phosphorus and acidification. Implementing this regulation should ensure that climate risks are fully integrated into forward planning in RBMPs going forward.

The RBMP should explain how climate change adaptation has been taken into account in the planning process. The guidance also requires NRW to clearly set out how they are responding to climate change within the RBMPs and associated documentation. NRW Area Statements required under the Environment (Wales) Act 2016 are also intended to enable action on the ground by guiding collaborative action on the range of opportunities for nature-based solutions in catchments.

Source: [Natural Resources Wales](#)

Image: *River Basin Management Planning (Unsplash)*



## N12. Freshwater species and habitats

Natural Environment and Assets					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	N12. Freshwater species and habitats	Pests, pathogens and invasive species	More action needed	EERA	ESNR

### Summary of risk definition and description

The Technical Report suggests that future risks from pests, pathogens and invasive species for freshwater species and habitats will increase through changed thermal regimes with impacts on the distribution and spread of various diseases and INNS, the rate at which invaders competitively displace native species, or through their increased food consumption rates. Impacts of the risks from aquatic plants, molluscs, parasites and fish are described across the UK.

- Currently most of the INNS are arriving in Wales as a result of anthropogenic factors and their distribution is expanding. There is less information on pests and pathogens, but some of the INNS also carry pathogens.
- Current and future risk is assessed as medium for Wales with a major factor for distribution for all INNS in the UK being proximity to ports and temperature increases.
- Changes in trade patterns and developments in water infrastructure that enhance connectivity could impact this risk (such as water transfer).
- The likelihood of increased arrivals of pests, pathogens and INNS to the UK in the future, and the potential role of climate change in facilitating their establishment and spread, means more action is needed, particularly to improve capacity for rapid detection.
- WaREN is devising a new collaborative framework to help public and private bodies and community groups to tackle the significant impacts of INNS focussed on 16 INNS, including swamp stonecrop or [New Zealand pigmyweed](#) (*Crassula helmsii*). INNS also forms a cross-cutting theme in the State of Natural Resources Report (SoNaRRI2) and will form a cross-cutting theme in the forthcoming Welsh State of Natural Resources Report.

### Benefits of further adaptation action in the next five years

CCRA3 acknowledges that adaptation measures to manage pests, pathogens and INNS in freshwater are not straightforward owing to the different impacts on native or target species and complex factors affecting the species arrival, spread and establishment. However, it makes the following observations on further adaptive management:

- Enhanced monitoring and surveillance, and broader stakeholder engagement.
- The benefits of taking early action on eradicating or controlling pests, pathogens and INNS.
- The economic case for further uptake of existing adaptation measures to prevent introduction and establishment, rather than attempt to mitigate spread and address impacts (see also recommendations for [N2](#) on INNS).

## N13. Freshwater species and habitats

Natural Environment and Assets					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
OPPORTUNITY	N13. Freshwater species and habitats	New species colonisations	Sustain current action	EERA	ESNR

### Summary of risk definition and description

The following observations are made in the Technical Chapter:

- The evidence suggests that opportunities from climate change across species are assessed as low, both currently and in the future.
- It is suggested that climate is a less influential factor influencing change than other anthropogenic factors. Available evidence is cited on bird populations, non-native crab species, invertebrates, crustaceans, fish and freshwater plant species although the evidence base for this opportunity is limited.
- Many of the adaptation actions that are taken to combat the risk to freshwater species ([N11](#)) will facilitate opportunities, therefore sustain current action is recommended.
- Opportunities for freshwater species may not only enhance biodiversity but they may also contribute to ecosystem services, especially cultural ones such as recreational angling and enjoyment of wildlife, with possible associated business opportunities.

### Benefits of further adaptation action in the next five years

The CCRA3 Technical Report recommends that maintaining current adaptation as detailed in N11 is sufficient, unless there is a desire to promote any opportunities such as the arrival of rare and/or iconic species, in which case specific actions might be needed.

## N14. Marine species, habitats and fisheries

Natural Environment and Assets					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	N14. Marine species, habitats and fisheries	Changing climatic conditions, including ocean acidification and higher water temperatures	More action needed	EERA	ESNR

### Summary of risk definition and description

Marine ecosystems are impacted by climate change through effects on the distribution and abundance of species groups including plankton, fish, seabirds, and marine mammals. Negative impacts on priority habitats of high biodiversity value may occur including changes to species and relationships between species groups that have a vital role in habitat resilience. The CCRA3 Technical Report suggests that:

- Climate-related changes in UK seas have been especially marked by a warming trend.
- There is good evidence to suggest major changes will occur to the marine environment under both +2°C and +4°C at 2100 warming scenarios but it is difficult to be precise on specific details due to multiple risk factors and the interconnectivity of marine ecosystems.
- Risk magnitude for this topic is projected to increase from medium at present to high in the future. There is also high potential for significant thresholds to be crossed causing irreversible changes.
- Current policy lacks detailed actions that include specific outcomes for the marine sector, plans for progress and reporting that recognise the scale of climate change risks.
- More action is needed now to both manage existing risks and to better prepare for the scale of future change based, for example, upon a stronger role for [Marine Protected Areas](#) (MPAs).
- Changes in fisheries policy, international trade and access to markets resulting from the UK's departure from the EU will likely have major implications for this risk.
- The new [National Marine Plan](#) (2019) introduces a 20 year guiding framework to support sustainable decision making for Welsh seas, recognising the importance of ecosystem resilience, the value of biodiversity and the need to tackle climate change taking forwards EU Habitats Directive commitments ([Conservation of Habitats and Species Regulations 2017](#)).
- Detailed implementation plans are yet to be provided with no specific mention of addressing impacts of climate change on fisheries within the Fisheries Sector Objective or for marine species. The Marine Area Statement published by Natural Resources Wales includes a specific theme for 'building resilience of marine ecosystems.'

### Benefits of further adaptation action in the next five years

The CCRA3 assessment recognises for both biodiversity and fisheries that the complexity of marine ecosystems is a major challenge for attributing risk, especially due to current constraints on monitoring data and understanding of processes. The Technical Report recommends the following approaches to facilitate adaptive management:

- Better implementation of existing measures through improved management and institutional arrangements including MPAs (policy, legal, fisheries planning, conservation objectives, risk preparedness, habitat restoration) particularly related to expected future shifts in distributions and their subsequent impacts.
- Clearer assessment and implementation of sustainable fisheries yields in the context of present and future climate change.

- 
- Better monitoring of ecological changes and their relationship with the physical environment and assessment of progress on biodiversity and fisheries goals.
  - Further research on the climate sensitivity of trophic interactions from plankton to fisheries, seabirds and mammals and the sensitivity of UK aquaculture species to multiple climate change drivers.
  - The [Wales National Marine Plan](#) (2019), [Wales Marine Fisheries Advisory Group](#), MPA management, continued discourse on 'EU-exit and Our Seas' and NRW [Welsh Marine Evidence Strategy](#) (2019-25) all provide opportunities to build adaptive management approaches in Wales.



## N15. Marine species, habitats and fisheries

Natural Environment and Assets					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
OPPORTUNITY	N15. Marine species, habitats and fisheries	Changing climatic conditions	Further investigation	EERA	ESNR

### Summary of risk definition and description

The analysis in the Technical Report suggests that the arrival of warm water species into UK waters provides new opportunities for biodiversity and fisheries and that the level of opportunity may increase from medium at present to high in future, although there is considerable uncertainty. It places emphasis on 'new' species for UK waters as distinct from ongoing shifts in existing UK species, including changes in biodiversity and ecosystem services including fisheries, that will impact on businesses and livelihoods.

- Detailed evidence for individual species in terms of expected rates of change in occurrence and abundance remains limited.
- Complicating factors include differential species response rates, species interactions (especially across trophic levels) and changes in socioeconomic factors such as fishing quotas and pollution loads.
- Limited discourse and profile in the marine and fisheries sectors and current policy specifically related to new opportunities for marine species.
- Evidence of species changes in catches and in some cases the sector has adjusted to take advantage of these changing opportunities, but this is also influenced by policy (quotas etc.) and consumer demand.
- MPAs will be important in providing habitats where new species of high biodiversity value can become established and hence opportunities to be realised. A key issue is the condition of MPAs and their associated habitats. Risks needs to be better managed to realise the opportunities.

### Benefits of further adaptation action in the next five years

The CCRA3 Technical Report recommends the following approaches to facilitate adaptive management:

- The need for biodiversity and fisheries management objectives to adjust to new species rather than continuing to pursue goals based upon historic species distributions.
- Further investigation of new species in the context of changing species distributions, species interactions and habitat quality, especially in the context of the MPA network and therefore evidence-based recommendations for further development and enhancement of the network.
- Improved monitoring data for fisheries on changing species movements and catches in order to better inform policy decisions on sustainable quotas for new species.
- Monitoring, scientific information, regular updates of fisheries policy (e.g. to set maximum catch potential for current species, include new species in policy) alongside awareness raising in the fishing sector.

## N16. Marine species and habitats

Natural Environment and Assets					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	N16. Marine species and habitats	Pests, pathogens and invasive species	More action needed	EERA	ESNR

### Summary of risk definition and description

The CCRA3 Technical Report outlines the main risks of pests, pathogens, and INNS on the marine environment, biodiversity value and ecosystem services, including fisheries, suggesting that the complexity of the marine environment means that considerable uncertainty remains for this risk. However, based upon available evidence, the following observations are made:

- The inter-connectivity of oceans and seas mean that the diffusion of pests, pathogens and INNS is less constrained than on land and the potential risk is considerably exacerbated by globalisation of trade and travel, particularly shipping.
- Risks from pests, pathogens and INNS will increase in proportion to the degree of future additional marine warming but there is considerable uncertainty on how this will occur because of other change such as acidification, salinity, stratification and pollution. The technical report assesses that this risk magnitude will rise from medium today to high in future.
- Despite current institutional risk assessment procedures providing some adaptive capacity to reduce risk, there remains an urgent need for more action to improve preparedness and address some of the key uncertainties.
- There are interdependencies between this risk and risks to human health and livelihoods including aquaculture and marine heritage.
- It is not yet clear how plans for continued international collaboration (including with the EU) will be taken forward following EU exit including surveillance, monitoring and horizon scanning.
- Welsh Government have committed to improving biosecurity measures in marine proposals and developing contingency plans for newly arrived INNS as part of [Prosperity for all: A Climate Conscious Wales](#) via an INNS Portal, guidance and commitments in the [Welsh National Marine Plan](#) (2019)

### Benefits of further adaptation action in the next five years

The CCRA3 Technical Report recommends the following approaches to facilitate adaptive management:

- Collect long-term data to better understand how marine pests, pathogens and INNS are affected by extreme events, climate variability and climate change.
- Improve horizon scanning and modelling capability for INNS and pathogens, and improved forecasting of outbreaks. Improved data and forecasting capability would also allow further investigation of the role of climate-related parameters in risk assessment.
- Work with key groups and local organisations, community groups fishing operators, practitioners, port and harbour authorities (including marinas) local angling networks, divers etc. to improve surveillance monitoring and awareness including further use of citizen science.
- Improve understanding of factors that contribute to disease-resistant organisms.
- Improve understanding and contingency planning for emergent risks, especially for novel pathogens.

## N17. Coastal species and habitats

Natural Environment and Assets					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
<b>RISK &amp; OPPORTUNITY</b>	N17. Coastal species and habitats	Coastal flooding, erosion and climate factors	<b>More action needed</b>	EERA	ESNR

### Summary of risk definition and description

The analysis in the CCRA3 Technical Report addresses coastal erosion and flooding together as inter-related and co-evolving processes affecting coastal morphology and flood risk. It recognises the need to develop an integrated systems approach for adaptive risk management. This might result in both habitat and species loss and gain through accretion, or coastal evolution providing new habitats and opportunities for biodiversity.

The analysis suggests that:

- The magnitude of risk to coastal species and habitats from changing climatic conditions is projected to increase from medium at present to high in the future. This risk is especially influenced by the rate and magnitude of sea level rise which more recent projections including UKCP18 suggest may be higher than assumed for CCRA2.
- Overall progress on managing this risk remains limited, although there are increasing numbers of positive local examples that can be highlighted.
- Significant barriers remain and for much of the coast there is an increased risk of lock-in to an unsustainable future.
- Evidence indicates that adaptation through effective implementation of nature-based solutions, including managed realignment and habitat restoration, can reduce the risks and provide multiple benefits and potential opportunities.
- The wider role of agriculture and forestry to benefit flood risk management, water quality, soil quality, biodiversity and landscape character. This will also have benefit for production too.
- Adaptation strategies need to be designed to be more flexible and robust against the wider range of climate change projections, and especially for higher rates and magnitudes of sea level rise.
- The CCRA3 Technical Report provides data on increases in designated areas at risk of coastal flooding for Wales (+2°C and +4°C at 2100 scenarios with low population, figure 5).

Assets at significant risk	Baseline (Ha)	2050s 2°C	2080s 2°C	2050s 4°C	2080s 4°C
Most important habitats exposed to frequent flooding	40,006	23%	28%	28%	32%
<a href="#">Ramsar areas</a>	8,361	33%	39%	40%	45%
<a href="#">Special Areas of Conservation</a>	21,501	22%	26%	26%	28%
<a href="#">Special Protection Areas</a>	10,144	18%	23%	23%	27%

Figure 5: Increase in designated areas at significant risk of coastal flooding (frequency of 1 in 75 year or greater) for Wales, including +2°C and +4°C at 2100 scenarios with low population. The risk is assessed to areas to landward of coastal defences but does not include changes in inundancy frequency and associated risk for habitats on seaward side (taken from Natural Environment and Assets technical chapter).

In Wales, the [National Habitats Creation Programme](#) has projected habitat losses of 4,663ha by 2105 (assuming continuation of current rates of sea level rise) and is developing a strategy to replace these losses. The [National Strategy for Flood and Coastal Erosion Risk Management](#) (2021) proposes a shift towards more nature-based solutions<sup>4</sup>. Estimates have been established of compensatory habitat that will be needed to implement the various Shoreline Management Plan (SMP) policies over a 100 year period. Targets will be agreed on compensatory habitats for Wales' four SMPs, in conjunction with sediment and erosion tracking research through the Wales Coastal Monitoring Centre.

## Benefits of further adaptation action in the next five years

The CCRA3 Technical Report recommends the following approaches to facilitate adaptive management:

- Improved recognition of the synergies achieved from restoring and protecting coastal habitats, both for their biodiversity value and for their ecosystem services, notably in providing additional resilience against flood and erosion hazards, and for carbon storage.
- Refine and update SMPs to improve linkages with Flood Risk Management Plans so that the interaction between erosion and flooding hazards are better managed together.
- SMPs and other coastal plans need to be refined to recognise the uncertainties in planning for climate change risk by developing multiple adaptation pathways, with the preferred option.
- More detailed systematic surveying of habitat opportunities to update the existing, mainly smaller-scale surveys and upgrade in data quality to understand coastal sediment budget and, crucially, identify areas of sediment loss and gains.

<sup>4</sup> This approach also recognises that flooding can be beneficial for some priority habitats.

## N18. Landscape character

Natural Environment and Assets					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK & OPPORTUNITY	N18. Landscape character	Climate change	Further investigation	EERA	ESNR

### Summary of risk definition and description

The Technical Report outlines how future changes to landscape character will occur from a range of natural responses to change climate including biodiversity, soils, geomorphology, hydrological processes, coastal processes, changes in land use and agriculture, managed change (e.g. floodplain restoration, managed coastal realignment). Changes will also result from a wide range of socioeconomic factors as well as effects of severe and abrupt extreme events such as drought and wildfires. CCRA3 suggests that:

- Risks and opportunities from climate change for this topic are assessed as increasing in magnitude from medium at present to high in the future.
- Current adaptation plans are limited although there are some important developments at local level that show increasing recognition of the issues added value from also linking with landscape change to carbon sequestration and storage.
- Assumptions about land use change are generally made based upon a single climate change pathway and current plans cannot be considered to be robust against the full range of possible future climate changes, especially at the upper end of projections.
- Investigation of different future scenario pathways is needed to investigate the relationship between controllable and less controllable aspects of landscape change including how they relate to target outcomes and public preferences.
- Welsh Government's Planning Policy recognises that climate change is likely to have significant impacts on landscape character, historic buildings, local distinctiveness and quality.
- In Wales, [research undertaken](#) by the University of Gloucester for Natural Resources Wales used a high-level approach to qualitatively assess climate change risks for generic landscape types and the resulting strategic planning implications for specific places and their distinctive characteristics. The analysis was based on judging the effects of climate change outcomes over the period from 2019 to 2050. It produced landscape narrative for 14 landscape types, maps and datasets.

### Benefits of further adaptation action in the next five years

The CCRA3 Technical Report recommends the following approaches to facilitate adaptive management:

- Improved collaboration between local and national government in developing a cross-scale planning framework for landscapes that integrates climate change responses, both adaptation and mitigation.
- Use of 'landscape narratives' to better understand different public perceptions of change to help reveal underlying understanding of nature.
- Further development of joint research programmes and strategies linking the natural environment and cultural heritage to define and investigate common adaptation outcomes for specific landscape types and locations.
- Utilising [LANDMAP](#) to plan adaptation and Net Zero outcomes at a landscape level.

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## 5. Infrastructure



*Menai Bridge from Bangor to Porthaethwy: Unsplash*

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The CCRA3 Technical Report examined the evidence of climate change impacts organised across 13 identified key risks covering infrastructure networks, transport, energy, water supply and information technology. These infrastructure networks support wellbeing in Welsh communities and underpin the Welsh economy. While the impacts of coastal and river flooding and erosion are still of major concern, CCRA3 also identifies the role of severe weather, identifying an adaptation planning gap in response to drought, the effects of storms, lightning and high winds. CCRA3 also identifies the need to take climate risks into account related to the types of changes to transport, infrastructure and land use that are required to meet the Net Zero emissions target.

Thinking has developed in CCRA3 related to cascading risks, suggesting that any risk has the potential to have a propagating impact across the network or indeed other networks via cascade failure, the consequences of which have far reaching social and economic disruption beyond the impact itself. CCRA3 has also identified lock-in risks, for example, the reliance of infrastructure on the electricity network which has itself been identified as having an adaptation shortfall.

The analysis suggests that socioeconomic trends will continue to influence demand for services and infrastructure such as digitalisation, changes to the work environment (noting the shift towards home working resulting from the COVID-19 pandemic), as well as long-term policy shifts. This will provide opportunities to enhance adaptive capacity in both new and existing infrastructure.



This section provides:

- A summary and description of each Infrastructure Risk.
- Suggestions from CCRA3 on the benefits of further adaptation over the next five years.

The Assessment was supported through provision of the Welsh policy context including information from:

- National strategy and planning: [Future Wales National Plan](#) 2040 (2021), [Wales Infrastructure Plan](#) (2019), [Llwybr Newydd: Wales Transport Strategy](#) (2021) and [Marine Plan](#) (2019) and commitments in Welsh Governments' [Prosperity for All: A Climate Conscious Wales](#) (2019).
- Area based plans: Water Resource Management Plans, Shoreline Management Plans, River Basin Management Plans and Local Resilience Plans.
- The plans of key groups and organisations: [Wales National Infrastructure Commission](#), [Wales Resilience Forum](#), Local Resilience fora and water, transport and energy companies.

The CCRA3 Technical Report recognises that these plans and strategies place a major emphasis on the role of resilient ecological networks, green infrastructure and nature-based flood risk management in managing climate risks to infrastructure over the long term. References to the Welsh policy context are made throughout this section.

Most of the urgency scores related to infrastructure have remained the same as in CCRA2, but in some cases they have changed for Wales as shown in the table below.

Risk, Opportunity or Risk and Opportunity	Urgency Score CCRA2	Urgency Score CCRA3
I6. Risks to hydroelectric generation from low or high river flows	Watching brief	Further investigation
I7. Risks to subterranean and surface infrastructure from subsidence	Watching brief	Further investigation
I10. Risks to energy from high and low temperatures, high winds, lightning*	Research priority/ Sustain current action	Further investigation
I11. Risks to offshore infrastructure from storms and high waves	Research priority	Sustain current action
I12. Risks to transport from high and low temperatures, high winds, lightning*	Research priority/ Sustain current action	More action needed
I13. Risks to digital from high and low temperatures, high winds, lightning*	Research priority Sustain current action	Further Investigation

\*These risks were split between hazards rather than infrastructure asset in CCRA2, but overall, the risk levels for each have increased.

There follows a summary of all climate risks and opportunities for Wales related to infrastructure.

# I1. Infrastructure networks (water, energy, transport, ICT)

Infrastructure					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	I1. Infrastructure networks (water, energy, transport, ICT)	Cascading failures	More action needed	Economy, Transport and North Wales	ESNR

## Summary of risk definition and description

Analysis in the CCRA3 Technical Report indicates that the vulnerability of interconnected systems may be significantly underestimated and that, despite examples of good practice emerging, there is an adaptation shortfall to manage the risk of cascading infrastructural failure (figure 6). The most significant cascades identified through commissioned [CCRA3 research](#) highlights the following:

- Transport infrastructure overheating and disruption to IT and communications services resulting in transport infrastructure damage and delays.
- Water and sewerage infrastructure flooding, reduced water quality and power supply disruptions
- Transport hubs and infrastructure flooding, leading to power supply and transport disruption.
- Damaging water flows, slope or embankment failure leading to transport infrastructure damage.

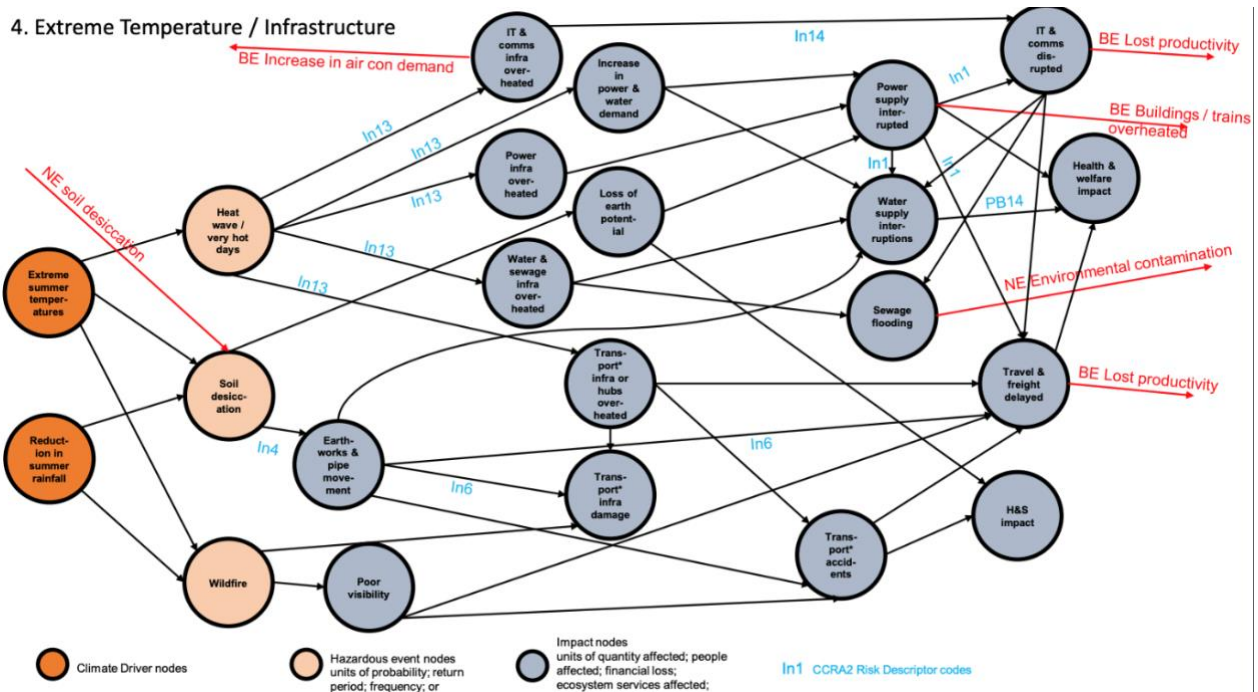


Figure 6: Example of how risks can interact with each other when extreme temperatures and reduced summer rainfall affect infrastructure. The three outcomes of heatwaves, wildfire and soil desiccation can result in a series of impacts on infrastructure which can lead to other impacts across the sector and beyond (from Infrastructure technical chapter).



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CCRA3 also identifies the following key issues:

- Lock-in risks stemming from the reliance of new infrastructure on electricity and information and communications technology (ICT) with all infrastructure sectors requiring power for some (if not all) of their assets.
- The introduction of new interdependencies in the developing infrastructure system ([digital twins](#), driverless transport, real-time management of assets).
- By tackling individual risks on individual infrastructure networks the risks to individual components or systems are reduced. However, opportunities and efficiencies that could be gained by taking a whole-systems approach are often missed.

The [National Infrastructure Commission for Wales](#) was established in 2018 as a non-statutory body to advise and make recommendations to Welsh Ministers on economic and environmental infrastructure over the next 30 years. Its remit extends to all sectors of economic and environmental infrastructure including energy, transport, digital communications, water and sewerage, drainage solutions, flood and coastal erosion risk management and waste management. It includes both devolved and non-devolved infrastructure. A key focus is climate resilience challenges including the risks of sea level rise, flood risk, and the proximity to the coast of settlements and road and rail links.

The case studies and literature support an assessment of current high magnitude of risk with high confidence, with disruption in urban areas potentially impacting hundreds of thousands of people annually. CCRA3 research supports a continuation of high magnitude risk in the future, given that the size of the impact from cascading effects increases over time.

## Benefits of further adaptation action in the next five years

The CCRA3 Technical Report recommends the following approaches to facilitate adaptive management:

- Developing better understanding of cascade failures and improved efforts for data sharing could significantly reduce the adaptation shortfall e.g. working via existing Local Resilience Fora to understand the nature of cascading risks and develop appropriate institutional conditions for adaptation.
- Bringing forward adaptation work related to the protection of electricity substations avoiding annual losses by installing planned flood protection measures ahead of schedule.
- Establishing systems of recording and monitoring impacts caused by cascading failures from weather and climate related disruptions.

## I2. Infrastructure services

Infrastructure					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	I2. Infrastructure services	River and surface water flooding	More action needed	Economy, Transport and North Wales	ESNR

### Summary of risk definition and description

The CCRA3 Technical Report outlines how future river and surface water climate change impacts are a major, high level risk to all infrastructure and that, despite progress with flood defences, risks are not being managed effectively with an adaptation shortfall which will require further Government intervention. Groundwater flooding remains a small proportion of the UK and Wales based risks.

- A commissioned [CCRA3 Future Flooding project](#) identifies that currently a significant proportion of infrastructure assets in Wales have a greater exposure to surface water than river flooding (figure 7).
- Extensive modelling of future risk has been completed via the above research. The results indicate that all infrastructure assets in Wales will face increased exposure to surface water risk. In some scenarios, a potential doubling of risk presents issues for the rail network in Wales, the standard of protection afforded by fluvial flood defences and future costs for maintaining flood defences, sewer modelling and design and solid waste sector costs related to landfill sites. This scenario assumes a policy of 'no additional action' with an absence of any further adaptation.
- Potential risks from river flooding under climate change from the same study suggest that risks to sewage treatment sites, railway lines and railway stations will increase in risk (all other infrastructure types are projected to decrease in risk).
- There is a danger of lock-in if flood defences and stormwater systems are under engineered to cope with projected changes in climate.
- In Wales, RBMPs have been produced for western Wales; Severn and Dee rivers and 11 catchment summaries focus on climate risks soils, water, trees, biodiversity, water demand and supply and character. As a result, [Natural Resources Wales \(2018\)](#) assesses that the following number of infrastructure sites are at risk from being affected by flooding with climate change: Dee: 445, Severn: 1,658 and western Wales 1,658.

Infrastructure Asset	Exposure to surface water flooding (1:30 or greater)	Exposure to river flooding (1:75 or greater)
Water sites (no.)	62	35
Sewage treatment works (no.)	126	60
Power stations (no.)	0	0
Electricity substations (no)	72	57
Rail length (km)	809	345
Rail stations (no.)	79	30
Landfill sites	0	0

Figure 7: Number or length of infrastructure assets currently exposed to 'significant' surface water or river flooding in Wales (from Infrastructure technical chapter).

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Evidence on the impact of flooding events on infrastructure in the UK supports a current high magnitude with high confidence. The analysis suggests for the whole of the UK, that existing policy frameworks for flood risk management exhibit governance and regulatory barriers related to roles and responsibilities and in some cases poor coherence between policies and informational failures. This stems from uncertainty around climate change, together with the complexity of current and future interdependencies between different infrastructure assets. It is the judgement of the authors that without further adaptation, the risk will remain high under all assessed climate scenarios.

However, there is an extensive policy framework for managing flood risk to infrastructure assets set out in the Infrastructure Technical Chapter. Good progress has been made in investment in flood defences, though various barriers exist to maintaining flood risk at today's levels in the future. These include governance and regulatory barriers, when a clear split of roles and responsibilities and/or poor coherence between policies hinder action, and informational failures, stemming from the uncertainty around climate change together with the complexity of current and future interdependencies between different infrastructure assets.

## **Benefits of further adaptation action in the next five years**

The CCRA3 Technical Report recommends the following approaches to facilitate adaptive management:

- The development of consistent indicators of network resilience to flood risk across all critical national infrastructure sectors and networks.
- Identification of areas on the road network that are most vulnerable to flooding, as well as those crucial for emergency services, e.g. access to hospitals.
- Exploring the potential benefits of blue and green infrastructure for building climate resilience and associated economic analysis.
- Low-regret measures including provision of tools and information.
- Screening climate risks in public and private investments.
- Appropriate policy and regulation.
- Disclosure of climate risks/uptake in commercial finance.
- Supporting innovative risk spreading (insurance).

## 13. Infrastructure services

Infrastructure					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	13. Infrastructure services	Coastal flooding and erosion	Further Investigation	Economy, Transport and North Wales	ESNR

### Summary of risk definition and description

Data from CCRA3 shows how mean sea level will continue to rise around the UK, between 0.27 and 1.12 metres by 2100 (relative to 1981-2000) with larger rises considered possible due to potential marine ice sheet instabilities. The CCRA3 Technical Report analysis indicates that:

- Extreme water levels are therefore very likely to increase during the 21st century and beyond, and without further adaptation (e.g. raising flood defences, managed retreat), the projected increases in extreme water levels will significantly increase coastal flood and erosion risk.
- For Wales, like other parts of the UK the key concerns are the types of infrastructure exposed to coastal flooding and erosion including clean and wastewater sites, electricity generation and distribution sites and transport networks (e.g. Welsh railways are particularly exposed with 312km of rail considered to be at risk (figure 8). Increased scour and coastal landfill are also highlighted as key concerns.
- Long term planning is in place through SMPs for the full length of the Welsh coastline. These focus on planning for sea level rise and climate change for the next 100 years and whether to adopt approaches of ‘hold the line’, ‘no active intervention’ and ‘managed retreat’. Although SMPs are in place for most of the UK, CCRA3 suggests that adaptation responses are inadequate to manage the levels of increasing risk in the future.
- [Wales Flood and Coastal Erosion Risk Management Strategy](#) (2021) recognises coastal impacts on people, communities and buildings from flooding and erosion and highlights efforts to introduce interventions which use natural systems to reduce negative impacts. This sets the overall policy framework for Local Flood Management Strategies delivered through Natural Resources Wales and local authorities. It outlines the strategic approach of the Welsh Government, Natural Resources Wales and others to reduce risk including more nature-based solutions and catchment approaches.

Infrastructure Asset at 1:75 or greater risk of coastal flooding (present day)	Assets at risk in Wales
Water sites (no.)	8
Sewage treatment works (no.)	18
Power stations (no.)	0
Electricity substations (no)	7
Rail length (km)	312
Rail stations (no.)	12
Landfill sites	0

Figure 8: Number or length of infrastructure assets currently exposed to ‘significant’ coastal flooding across Wales (from Infrastructure technical chapter).

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Present day risk is medium, as studies since CCRA2 have provided further evidence of the nature and magnitude of observed changes in mean sea-level rise, storms and waves and associated risks. Medium magnitude with low confidence is given for future scenarios.

## **Benefits of further adaptation action in the next five years**

The CCRA3 Technical Report suggests that agencies, authorities and government face the ongoing challenge across the UK to produce practical portfolios of adaptation options that are technically feasible, balance costs and benefits, that can attract appropriate finance, and are socially acceptable. Developing practice and processes to managing this risk is necessary. Further work would be beneficial on managing interacting risks from compound events (i.e., flooding from both marine, fluvial and pluvial sources occurring concurrently or in close succession). The previous lack of consideration of compound flooding means that flood risk has likely been underestimated around UK coasts, particularly along the south-western and western coasts. This should be addressed in future assessments of flood risk and flood management approaches.

## 14. Bridges and pipelines

Infrastructure					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	14. Bridges and pipelines	Flooding and erosion	Further Investigation	Economy, Transport and North Wales	ESNR

### Summary of risk definition and description

The CCRA3 Technical Report suggests that research is still needed to define links between the forecasts and the actual projected impact at the local, regional and national environment level on bridges and pipelines. Key factors which affect both sets of assets include the level of rainfall, frequency of severe events, changes in wind climate, the degree, extent and depth of flooding, increased run-off, sea level rise, increased rates of erosion and the exacerbation of land and ground movement.

- There are no quantitative projections for climate change impacts for pipelines. The main categories of weather events and environmental hazards for pipelines include flooding and heavy rainfall (including saturated and dry ground conditions), snow and ice, increases in temperature, coastal and river erosion, storm events and high winds.
- For bridges, evidence is cited on key factors which need to be considered including high river flows and debris, more frequent higher in-river water levels, scour of bridge foundations, drying out of embankments and accelerated weathering-related deterioration, increased run-off and sea level rise.
- Both bridges and pipelines are affected by the resilience of road network. The impact of flooding on transport infrastructure is projected to have a number of significant cascading impacts on other infrastructure and emergency response.

The evidence supports a medium magnitude current risk for flooding and erosion on bridges and pipelines. The evidence supports medium magnitude for future risk with low confidence across all future climate scenarios assessed, owing to the lack of quantitative studies on future impacts on bridges and pipelines.

### Benefits of further adaptation action in the next five years

The CCRA3 Technical Report recommends the following approaches to facilitate adaptive management:

- Revision of design codes to account for the effects of climate change, specifically in relation to bridge foundation scour (case study 4) and effects of increased wetting and drying of soils in which pipelines are buried.
- A range of management measures through maintenance operations, improving collaboration with emergency managers, recognising emergency management as an integral function of managing infrastructure.
- Undertaking a national assessment of bridge and pipeline risks from climate projections.

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## Case study 4: Network Rail Wales Route Climate Adaptation Plan

This plan outlines actions to increase understanding of current weather resilience, potential impacts on infrastructure performance, safety risks and costs, implications for asset policies and investment decisions. Bridge failure is one of the key factors in the review and onward investment strategy by Network Rail.

Source: [Network Rail](#)

Picture: [Deganwy Station, Conwy, Wales](#)  
(Unsplash)



## 15. Transport networks

Infrastructure					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	15. Transport networks	Slope and embankment failure	More action needed	Economy, Transport and North Wales	ESNR

### Summary of risk definition and description

The CCRA3 Technical Report suggests that increased incidence of high rainfall combined with preceding periods of desiccation and cracking are expected to lead to an increase in incidents of slope failure within the transport network. Extreme weather is expected to increase the rate of these deterioration processes although these are not yet fully understood. Evidence focuses on the following:

- The risks associated with railway cuttings, the effect of trees on risk due to slope and embankment failure, the impact of soil moisture fluctuations, vegetation management and approaches to monitoring slope condition.
- That future climate change will increase landslide risks. There is therefore a risk of lock-in if future risks are not considered given the long lifetime and changes in land use.
- Approaches of Network Rail through their Weather Resilience and Climate Change (WRCC) programme including vegetation management, investigation of earthworks failures, monitoring pilot among other initiatives.
- Wales and West Utilities, working with Landmark Information Group, have developed an infrastructure vulnerability mapping tool as referenced in [Prosperity for All: A Climate Conscious Wales](#) (using sea level rise inundation, new tide lines, tidal flooding, fluvial flooding) for different emission scenarios.
- Welsh Government and the Coal Authority have undertaken a Spoil Tip Review in 2020 categorising the risk of spoil tips to transport and other essential infrastructure.
- The critical role of Welsh local authorities and Welsh Local Government Association who are responsible for 32,000km (95%) of roads in Wales, alongside Welsh Government responsibilities for the trunk and motorway network and the need for both to recognise the potential impact of future climate change on slope and embankment failure in their strategies, plans and investment.
- The importance of adaptation measures required on individual stretches of waterways, both canals and rivers.

The length of network exposed to this risk, its vulnerability to the hazard and the observed impact of single events indicates this risk is of medium magnitude now and in future. This is given with low confidence, as there is no nationwide assessment of the economic and social consequences of slope and embankment failure on transport networks.



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## Benefits of further adaptation action in the next five years

The CCRA3 Technical Report recommends the following approaches to facilitate adaptive management:

- More action is needed to better understand asset, slope and embankment condition and exposure, and the standards of new adaptation interventions.
- There is a continued need to factor in projected increases in heavy rainfall events into long term renewal programmes for earthworks, especially for the rail network and to develop appropriate management approaches including greater use of instrumentation to monitor slope behaviour.
- More detailed characterisation of engineered soil assets.
- Greater use of soft engineering techniques such as vegetation management to reinforce vulnerable slopes and increasing the inspection frequency of slopes and embankments.
- More frequent maintenance of drainage systems.

## 16. Hydroelectric generation

Infrastructure					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	I6. Hydroelectric generation	Low or high river flows	Further investigation	EERA	ESNR

### Summary of risk definition and description

The Technical Report analysis outlines the vulnerability of hydroelectric power to both low and high flows. The impact of climate change on hydro output is very much dependent on future patterns of rainfall and temperatures together with changes in the water catchment area. The analysis suggests that:

- Low flows reduce power output, whereas extreme high river flows could damage generation equipment and associated infrastructure, including spillways and weirs. Damage from extreme high river flows can be exacerbated by debris carried by the river but can also have a positive impact through the increased power output.
- The impact of lower or higher rainfall on flows is mediated by the surrounding catchment area, and the rate at which water reaches the river, reservoir or impoundment. Energy generation from hydro schemes is closely linked to changes in runoff. Impacts on the local power network may occur through differences in generation between summer and winter.
- Impacts on generation from severe weather can lead to loss of revenue to scheme operators caused by a reduction in generation in part due to reduced rainfall. This may have effects on both the distribution networks as their supply profile changes, as well as gains for other electricity suppliers who make up any shortfall.
- If schemes do not consider future flow regimes, they could be locked into sub-optimal operation or severe damage during extreme flow events.
- In Wales, Gwynedd remains the local authority area with the greatest number of [hydropower projects in Wales](#), with 141 projects totalling 59 MW in 2018. Due to hosting Rheidol Power Station, Ceredigion has the greatest hydropower capacity with just under 71 MW across 28 projects.

The present day risk magnitude score for Wales is judged as low due to a lack of evidence indicating an impact of climate change to date. There are no studies that evaluate the potential impacts of extreme high flows associated with either 2°C or 4°C global warming scenarios and the costs of replacing and repairing damaged equipment could in principle be in the £10s of millions, which would be considered a medium magnitude

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## Benefits of further adaptation action in the next five years

The CCRA3 Technical Report recommends the following approaches to facilitate adaptive management:

- Incorporating climate impacts into the design of new schemes together with risk assessments for existing infrastructure and appropriate action. Consideration of this in both site selection and design will enable owners to maximise the system outputs under future climate and minimise risks.
- For existing schemes, retrospective climate risk assessments can better inform operational planning and take action to protect assets and the downstream environment from harm during high water flows.
- Assessments need to include risks of damage to hydroelectric power infrastructure from extreme high flow events together with the implications of changing temperatures and the patterns of drought and rainfall on embankment safety.

## 17. Subterranean and surface infrastructure

Infrastructure					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	17. Subterranean and surface infrastructure	Subsidence	Further investigation	Economy, Transport and North Wales	ESNR

### Summary of risk definition and description

The Technical Report provides an overview of the risks associated with ground subsidence and collapse of pre-existing cavities in the ground (e.g. mine workings) from changes in soil water content, hydrology and vegetation change as a result of climate change. Key observations are that:

- Current impacts of subsidence affect residential and commercial property, transport infrastructure including railway track and road surfaces and buried infrastructure including electrical cables, sewage, gas and water pipelines. These are all vulnerable to damage and disruption.
- Subsidence, shrinkage and heave of high plasticity soils are expected to be exacerbated by projected increases in drought conditions and periods of prolonged heavy rainfall.
- Development of sinkholes after periods of prolonged rainfall, local flooding and erosion are also anticipated to be causes of damage.
- A knowledge and research gap exists around the potential impact of climate change on soils, landslips and subsidence in areas which have been mined including Wales.
- The buried and surface infrastructure exposed to subsidence risk have long operational lifetimes, so consideration of this risk for correct construction and maintenance is essential.
- Buried services are frequently collocated beneath or alongside transport corridors. [The CCRA3 interacting risks project](#) identified earthworks and pipe movements as starting points to cascading risks related to transport.
- With over 2,000 mining tips in Wales, 294 have been identified as high risk. Welsh Government and the Coal Authority are currently working together on an urgent Spoil Tip Review which will categorise tips related to whether they are a risk to critical infrastructure.

The available evidence indicates low current magnitude for this risk, though quantitative evidence on costs is generally limited so this assessment is given with low confidence. Climate drivers suggest a potential increase in magnitude to medium, although no quantitative impact projections exist therefore confidence in the risk scores is low.

### Benefits of further adaptation action in the next five years

The CCRA3 Technical Report recommends further research and investigation to fill knowledge gaps including:

- To produce more accurate and consistent data on risks from subsidence to focus on among other things: railway earthworks; sub-surface composition; soil properties; role of vegetation.
- Introduction by asset managers of increased monitoring in higher risk areas and assets including increased ground and weather monitoring to investigate the interdependencies of infrastructure and associated risks related to subsidence including the impact of climate change on soils, landslips and subsidence in areas which have been mined.
- Developing adaptation strategies to manage risks identified.

## 18. Public water supplies

Infrastructure					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	18. Public water supplies	Reduced water availability	Sustain Current Action	EERA	ESNR

### Summary of risk definition and description

The analysis in the Technical Report provides further evidence that the UK faces an increased demand for water in a changing climate. Analysis commissioned for CCRA3 indicates that water resource regions in England and parts of Wales are projected to be in deficit under a central population scenario and with 4°C global warming at 2100 without additional adaptation. The assessment suggests:

- Updated projections of future water availability for the UK [produced for CCRA3](#) provide analysis for the potential impact of climate change at several different scales of spatial aggregation and for a variety of population and adaptation scenarios. These water availability projections for the UK are the first of their kind to use the UKCP18 Climate Projections.
- This work found that the only future scenarios that result in a significant UK-wide supply-demand balance surplus are the ones in which additional adaptation action is taken to reduce demand or where the current and announced adaptation scenario is applied to the central population. This scenario includes the water companies' own ambitions for reducing per capita consumption.
- Adaptation efforts in the sector are well advanced, assisted by five yearly Water Resource Management Plans ([case study 5](#)) which take a 25 year outlook and used earlier UKCP projections. However, CCRA3 states that more action is needed in addition to current adaptation approaches.
- The challenge across the UK remains the reliable supply to regions where demand is highest and a deficit projected. Cross-regional transfers will need to be based on long-term modelling to ensure that regions from which water is being transferred do not experience a deficit.
- The study found that key interdependencies and cross-cutting risks related to water availability included disruption to power supply, river, surface and groundwater flooding leading to an increase in run-off and debris causing a reduction in water quality, direct water supply disruption from drought, impact on soil condition with subsequent water quality impacts and slope or embankment failures leading to reservoir failures.
- Figures 9 and 10 show supply-demand balance in the mid and late century in 2°C and 4°C global warming scenarios at 2100.

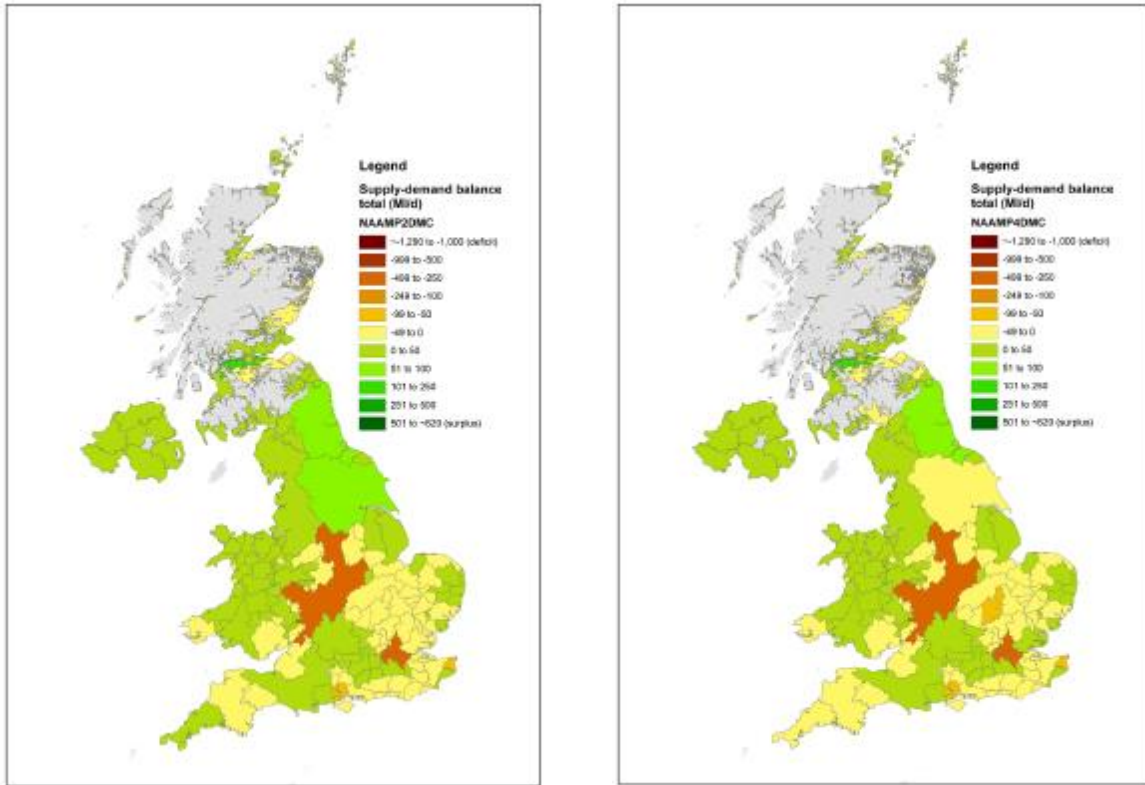


Figure 9. Supply-demand balance in the mid-century, in a +2°C (left hand side) and +4°C (right hand side) at 2100 scenario and central population projection and assuming no additional adaptation action, at the water resource zone scale (HR Wallingford, 2020). Grey indicates areas reliant on private supply.

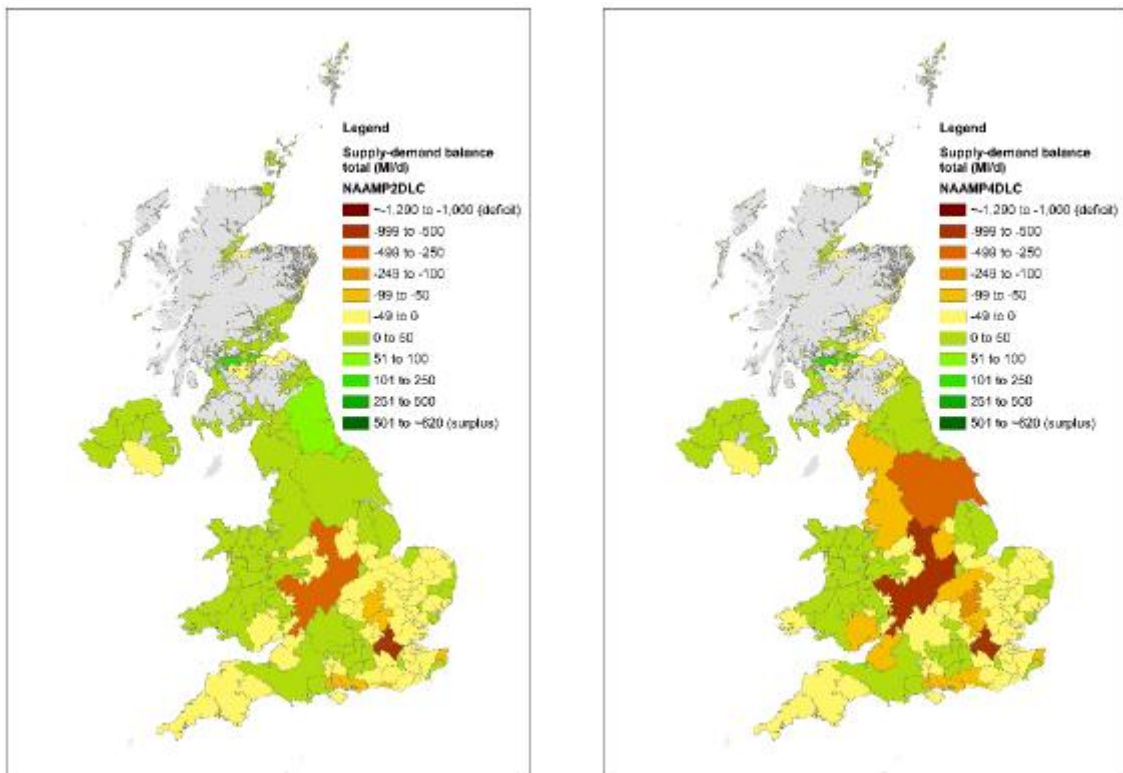


Figure 10. Supply-demand balance in the late-century, in a +2°C (left hand side) and +4°C (right hand side) at 2100 scenario and central population projection and assuming no additional adaptation action, at the water resource zone scale (HR Wallingford, 2020). Grey indicates areas reliant on private supply.

All water resource regions in Wales have a present day supply-demand surplus, giving a low magnitude score. This rises to medium in future scenarios (central population and ‘no additional adaptation’), as although the majority of Wales remains in surplus, supply-demand deficits are apparent in the southeast of Wales under all future scenarios.

## Benefits of further adaptation action in the next five years

The CCRA3 Technical Report recommends the following to facilitate adaptive management at an England and Wales level including demand management and new water resource options:

- Mandatory government-led scheme to label water-using products, linked to tightening building and water supply fitting regulations.
- Building resilience to 1 in 500 year drought and construction of supply infrastructure that supplies a further 1,300MI per day as recommended by the National Infrastructure Commission.
- Implementing metering for 95% of households by 2030-2035 and continuation of the [NERC Drought research programme](#).
- Regional breakdowns across the UK of what would be achieved with different levels of adaptation, from reducing leakage, adding new infrastructure (including desalination) decentralised supply, water efficiency standards and the role of water transfer from regions of surplus to regions of deficit.

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## Case Study 5: Water supply and demand concerns

In Wales, River Basin Management Plans produced by NRW and Water Resources Management Plans from water companies provide an overall indication of water supply and demand based on UKCP09 data.

There are four areas of concern related to climate change in terms of demand and supply: North Eyrí/Ynys Mon in North Wales, the SEWCUS area in South Wales covering Cardiff, Newport and the Valleys, Tywyn Aberdyfi in west Wales and Pembrokeshire where two future water deficit zones have also been identified using climate projections.



Source: [Natural Resources Wales](#)

Image: Caban Coch Dam Rhayader (Unsplash)



## 19. Energy generation

Infrastructure					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	I9. Energy generation	Reduced water availability	Watching Brief	EERA	ESNR

### Summary of risk definition and description

The CCRA3 Technical Report focuses on climate related risks to thermal plant for energy generation. Current risks to thermal plant arise from restrictions to either abstracting or discharging water into freshwater systems due to periods of low rainfall and/or in combination with elevated temperatures. Analysis of future risks to the sector suggest there are particular risks across the UK where inland thermal plant source water is required in areas which are likely to be vulnerable to drought.

- Wales' large thermal power generation is coastal rather than inland. Projections of future catchment water availability suggest there could be reductions in catchment water availability in south east Wales under +2°C at 2100 scenario by the mid-century which has implications for the siting of any future thermal generation plant. Technical Advice Notes (which cover hydroelectric schemes) are incorporated into Local Development Plans.
- There is potential for lock-in depending on the future mix of electricity supply technology and siting of thermal plant and other water intensive activities such as CCS. If this is sited in existing locations where there are likely to be restrictions on freshwater availability due to climate change the affected plant would be locked-in to these potential future constraints.
- The effects on the temperature of river, estuarine and marine waters is also relevant. An increase in average water temperature due to climate change further exacerbates the effects of returned cooling water on the aquatic environment and associated negative impacts on wildlife.
- Future freshwater requirements from energy plant are likely to compete with other uses such as agriculture and public water supplies as well as safe water levels required for the flora and fauna living within the catchment.
- To deliver Net Zero ambitions a new generation of electricity power options is likely. This will increase the turnover of current thermal plants and potentially create a stock of new energy technology associated with CCS, hydrogen, biomass and biofuel production and thus change the nature of these risks as compared to the current situation. This could potentially increase this risk if the technologies that are favoured have high water demand.
- While plans exist that consider the risks of water scarcity in the future for new developments, there is a lack of evidence on what measures could be taken by existing energy generation sites that rely on freshwater if scarcity increases in the future. Specifically, more analysis is needed for hydrogen and biofuel production to understand the risks.

Current risk is low, as Wales' large thermal power generation is coastal rather than inland. Assuming current patterns of development and technology remain, future risk is also low, though changes to the energy mix introduced by Net Zero policy could potentially increase this risk if the technologies that are favoured have high water demand. Confidence for this assessment is medium.

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## Benefits of further adaptation action in the next five years

The CCRA3 Technical Report recommends the following approaches to facilitate adaptive management:

- The evidence for risks to energy generation due to higher water temperatures and/or reduced river flows is kept under review, with long-term monitoring of risk levels and adaptation activity and additional consideration of the impacts of expansion in hydrogen and biofuel production.
- Climate projections for the future water resources available in different catchment areas being available to guide new infrastructure siting and cooling technology choices, for the new generation of energy generation for Net Zero, and especially for biofuel, biomass and hydrogen.
- The most obvious no-regret option is for further analysis of the possible risks with respect to water demand of new generation plant, and the linkages with the [risk 18](#) on water supply.

## I10. Energy

Infrastructure					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	I10. Energy	High and low temperatures, high winds, lightning	Further investigation	EERA	ESNR

### Summary of risk definition and description

CCRA3 provides evidence for current and future risks of severe weather to energy supply by drawing on research and case studies which highlight a wide range of risks from power outages to transport, health, water supply and industrial sectors and households. In summary:

- High and low temperatures can affect energy supply through effects on thermal generators, photovoltaic cells, reduce transmission and distribution, line faults, the running of gas compressor stations and solar.
- Impacts of wind for energy infrastructure result from wind-blown debris and fallen trees, disruption to transport, reduction in wind power, personal safety risks for staff, reduction of output from wind farms.
- Major impacts of lightning for energy infrastructure are physical damage, fire, power surge, and shock wave impacting trains, air travel, water supply, industrial processes and residential supply.
- Loss of energy supply, in particular electricity, is likely to lead to cascade failure.
- The Infrastructure Technical Chapter also provides data for Wales based on UKCP18 projections on numbers of summer days, tropical nights, cooling degree days, frost days, icing days and heating degree days suggesting notable change in future seasonal energy demand profiles.
- Since CCRA2 the UKCP18 projections for temperature changes have been published which inform thinking on this risk. The Infrastructure Technical Chapter suggests:
  - Limited evidence for how climate change will influence wind speeds.
  - Some evidence of a projected increase in the occurrence of winter storms over the UK.
  - 5–10% increase in windstorm intensity and frequency is sufficient to induce a failure to meet demand for the electricity network.
  - Uncertainties in relation to increases in lightning strikes and impacts on photovoltaics.
- The Climate Change Committee’s 2019 [evaluation](#) of the second round of Adaptation Reporting Power (ARP) reports and wider evidence from the energy sector is that the energy generation, transmission and distribution sector is making relatively good progress in adaptation, but further research is required on the potential impacts of wind speed and lightning on the electricity distribution network, particularly in relation to tree fall.

There are varying degrees of risk posed by these hazards to energy, as well as varying degrees of understanding of the future risk posed in various climate scenarios. The overall risk is scored at the highest level of risk across all hazards, which is high, with low confidence, for present day and for future risk. Current risk is low for temperature and high for wind and lightning. Future risk is medium for temperature and high for wind and lightning.

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## Benefits of further adaptation action in the next five years

The CCRA3 Technical Report recommends the following approaches to facilitate adaptive management:

- Further investigation on the implications of increased vegetation growth rates and the future risks of damage from falling trees.
- Incorporating climate change information into the decision making stages regarding the design of new assets and life extension of existing assets. For example, inclusion of climate risk assessment as part of project design and financial and economic appraisal.
- Further investigation on activities being implemented by the energy sector on existing plans to protect assets from increased lightning strikes.

## I11. Offshore infrastructure

Infrastructure					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	I11. Offshore infrastructure	Storms and high waves	Sustain current action	Not devolved tbc	Not devolved tbc

### Summary of risk definition and description

The analysis in the CCRA3 Technical Report describes how marine climate change including extreme storms impacts offshore infrastructure (such as equipment used by the oil and gas industry, wind, tidal stream and wave energy as well as communications, gas pipelines and power cables on or under the seabed). It summarises risks as follows:

- [UKCP18 Marine Report](#) (2018) provides UK marine climate projections in sea level rise, wave height, wind speed and current. It identifies vulnerabilities to offshore infrastructure related to destabilisation or degradation of mechanical structures, reduced energy yields and operating periods, loss of integrity of foundations and cabling systems caused by sediment transport during storms across the seabed and the access for maintenance and inspection activities.
- Offshore infrastructure is designed against limit states that are created by a single extreme load (e.g. from the largest wave in an extreme storm event) or by an accumulation of many small loading events (e.g. a fatigue failure). The maximum single extreme load is affected by climate change through the severity of the extreme storm event combined with the increase in sea level.
- There is a data gap on the current failure rates and structural performance for wind turbines, as well as uncertainty about potential future changes in loading and therefore stability and machine degradation.
- Since offshore infrastructure is designed for 30 - 40 year life, and the period for consenting and construction is five years, decisions now will affect the capacity and resilience of offshore infrastructure and energy supply in 2060.
- High reliance on offshore wind and subsea cables adds vulnerability to the electricity grid and resilience of these will be a key factor in achieving Net Zero targets.
- The length of experience of offshore wind farm operations and resilience is relatively short, due to the limited timespan of this industry to date, so long term effects are not yet fully understood.

The projected consequences of climate change on offshore infrastructure outlined above are generally low and in some cases represent a reduction in risk. However, the low confidence in the projected changes in the environment coupled with the short timescale of experience and evidence of offshore wind operations as well as the rapid growth of this infrastructure, its vulnerability to changes in environmental conditions, and its importance to our energy system, leads to a medium classification of the future magnitude of risk.

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## Benefits of further adaptation action in the next five years

The CCRA3 Technical Report suggests that offshore energy infrastructure stakeholders span government, the private sector and academia, and have the expertise and resources to implement climate-related adaptations in the design and operation of new infrastructure. However, the following recommendations are made to facilitate adaptive management:

- Further investigation into the potential changes in relevant climate metrics including wind and wave heights would better inform design and siting choices.
- Improve confidence in projections of the changing marine environment and the use of climate risk assessment in new project design and appraisal.

## I12. Transport

Infrastructure					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	I12. Transport	High and low temperatures, high winds, lightning	More action needed	Economy, Transport and North Wales	ESNR

### Summary of risk definition and description

The analysis in the Technical Report suggests although there are examples of good practice within individual transport modes and emerging activities taking place, the approach to managing climate risks across transport infrastructure is not comprehensive and is not being undertaken from a mobility or whole-systems perspective. The evidence focuses on:

- The effects of current extreme weather on rail infrastructure, road infrastructure, air transport and port operations based on commentary from CCRA2 analysis using UKCP09 Projections.
- The lack of data on the impact of high and low temperatures, wind and lightning on road infrastructure and other receptors.
- [The Interacting Risks study commissioned for CCRA3 Technical Report](#) focused on interdependencies and cascading risks in relation to transport disruption identifying risks from overheating, ICT services being disrupted, impacts on road and rail services, damaged infrastructure, wildfires and severe weather incidents.
- The analysis does not reflect the specific Welsh position and opportunities related to adaptation to transport risks as discussed below.
- [Future Wales: The National Plan 2040](#) (2021) and [Llwybr Newydd: Wales Transport Strategy](#) (2021) provide an opportunity to build adaptive management approaches in Wales to road, rail, air and water based transport planning and investment. Each has high level commitments to develop the resilience of transport infrastructure to the effects of climate change. Similarly, the [National Infrastructure Commission for Wales](#) have recognised the importance of this issue.

Although the risk is of a medium magnitude for the present day, the magnitude of the risk increases significantly in a changing climate. Given the high financial costs of infrastructure failure (particularly heat-related rail buckling), this increase translates into a high magnitude score in future. Confidence on future magnitudes is low as the assessment of impact of risks is variable across the different transport modes.

### Benefits of further adaptation action in the next five years

The CCRA3 Technical Report recommends the following general approaches to facilitate adaptive management:

- For new infrastructure, there are opportunities for mainstreaming climate change adaptation into planning and design. However, the analysis suggests that a priority should be the assessment of the transport system on a whole-system basis related to climate risk.
- Asset information collection by infrastructure managers.
- Establishing indicators for the climate resilience for roads.
- Improved data on disruption to ports and airports

## I13. Digital

Infrastructure					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	I13. Digital	High and low temperatures, high winds, lightning	Further Investigation	Economy, Transport and North Wales	ESNR

### Summary of risk definition and description

The CCRA3 Technical Report describes ICTs critical role in the operation of wider infrastructure networks as well as underpinning business activities, access to key services and wider communication. Digital outages can have significant effects on a locality and more broadly via interdependent infrastructure. The analysis focuses on the following key issues:

- Infrastructure such as water, power and transport, are increasingly controlled over telecommunications networks. Failure of telecommunications can lead to reduced capacity in a wide range of other essential services at local levels.
- While there is a general understanding of the interactions between ICT infrastructure and weather, quantitative projections assessing how climate change will affect infrastructure and services is not available.
- Information on the location of UK ICT infrastructure is also not available such as data centres, base stations and network connections. Information on location and connectivity is not publicly available, for commercial or security reasons, and so it is difficult to assess vulnerability to extreme events.
- Key potential risks include denial of access to affected sites and loss of power. Fibre and cables are vulnerable to flooding damage where they use bridges to cross rivers. There is risk of wind, ice and snow damage to overhead cables and damage from windblown debris.
- Intense or longer droughts and heatwaves can affect a range of ICT infrastructure because ground shrinkage can lead to failure of electrical, gas and water pipes, damaging co-sited ICT infrastructure.
- High summer temperatures, as well as rapid fluctuations in temperature and humidity, pose challenges particularly to data centres which need to be kept cool to operate.

Evidence of the specific impacts of high and low temperatures, high winds and lightning on ICT infrastructure is limited. There is no current evidence of significant disruption caused by these hazards on UK ICT infrastructure, leading to a current score of low but with low confidence owing to the limited evidence base in this area. The need for datacentres to be kept cool to operate, as well as the potential impact of longer droughts or heatwaves causing ground shrinkage and failure of co-sited electrical, gas and water pipes with associated knock-on impacts to ICT, indicates a potential increased source of risk in all future scenarios in this assessment. Future risk is therefore medium but with low confidence, owing to the lack of quantitative projections assessing how climate change will affect the frequency and magnitude of interruptions to digital services.

Disruption to ICT services is one of the most important contributors of risk through the different interacting pathways on other essential infrastructure. While National Adaptation Programmes across the UK acknowledge the risks to the digital sector, there is no evidence of specific actions to ensure the resilience of digital infrastructure to climate hazards.



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## Benefits of further adaptation action in the next five years

The CCRA3 Technical Report recommends the following to facilitate adaptive management:

- Further information is required to assess how climate change will affect the frequency and magnitude of interruptions to digital infrastructure for example, by monitoring the number of weather and climate related disruptions across the sector.
- Incorporating digital infrastructure into existing infrastructure climate adaptation plans.
- Ensuring that climate risk assessment is included in design financial and economic appraisal for ICT assets.
- Given that digital infrastructure underpins the operation of most other forms of infrastructure, and this role is likely to increase in the future, scrutiny of the resilience of this sector is needed.

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## 6. Health, Communities and the Built Environment



*Barmouth, Gwynedd (Pixabay)*

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The CCRA3 Technical Report summarises the evidence regarding the key risks and opportunities of climate change on health and wellbeing, communities, and the built environment. The evidence in this chapter is divided into 13 climate risks and opportunities which impact on the future wellbeing of Welsh communities. This section provides:

- A summary and description of health, communities and built environment risks.
- Suggestions from CCRA3 on the benefits of further adaptation over the next five years.

CCRA3 recognises that policy areas that address adaptation in this section are largely devolved and has considered the Welsh policy context, and its approach to forward planning from:

- National strategy and planning in [Future Wales: The National Plan 2040](#) (2021), [Flood & Coastal Erosion Risk Management Strategy](#) (2021), [Wales Infrastructure Plan](#) (2019), draft Healthier Wales (2019), [Llwybr Newydd: Wales Transport Strategy](#) 2021, Natural Resources Policy through the [Environment \(Wales\) Act 2016](#) and commitments in [Prosperity for All: A Climate Conscious Wales](#) and the [Wellbeing of Future Generations Act \(Wales\)](#) 2015.
- Area based plans: Water Resource Management Plans, Shoreline Management Plans, River Basin Management Plans and Local Resilience Plans.
- The plans and activities of key groups and organisations: Public Health Wales, [Wales National Infrastructure Commission](#), Wales Resilience Forum, Local Resilience fora, water, transport and energy companies, academic research and [Wales Historic Environment Group](#).

While considerable advances have been made regarding the strategic management of flood risk at national and local levels since CCRA2, the assessment finds that the risk magnitude remains high now and in the future for all parts of the UK with more action needed due to the scale of the risk.

High temperatures affect a very wide range of health and social outcomes. Research and reporting on heatwaves reveals the current lack of planning in systems, including for interactions between risks from combined exposures from air pollution, drought and wildfire. CCRA3 also suggests that there is a policy gap to address increased risks of contamination to food and drinking water from climate change impacts.

The assessment has also found that, given UKCP18 projections suggest greater sea level rise than had been projected previously, a more strategic approach is needed to identify and support communities at risk from coastal change. The evidence presented here suggests that adaptation to current climate risks is limited by a range of factors including implementation of planning policy, construction practices in new developments and fragmentation of services both locally (with local agenda setting priorities) and across sectors.

Most of the urgency scores related to health, communities and the built environment have remained the same as in CCRA2, but in some cases, they have increased for Wales, as shown in the following table.

Risk, Opportunity or Risk and Opportunity	Urgency Score CCRA2	Urgency Score CCRA3
H4. Risks to the viability of coastal communities from sea level rise	Research priority	More action needed
H6: Risks and opportunities from summer and winter household energy demand	Research priority	More action needed
H10. Risks to health from poor water quality	Sustain current action	Further investigation
H11. Risks to cultural heritage	Research priority	More action needed
H12: Risks to health and social care delivery	Research priority	More action needed
H13: Risks to education and prison services	Research priority	More action needed

It should also be noted that the COVID-19 pandemic may have long-term implications for the resilience of the health and social care sector. The pandemic has caused an additional stress on the health and social care system due to increased demand (likely to last until 2022) and additional pressures on local finances (likely to last longer term). More positively, the impacts of COVID-19 may have raised awareness of the importance of understanding major threats that can disrupt lives and livelihoods, including low probability, high impact flood events.

There follows a summary of all climate risks and opportunities for Wales related to health, communities and the built environment.

# H1. Health and wellbeing

Health, Communities and the Built Environment					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	H1. Health and wellbeing	High temperatures	More action needed	Health and Social Services Group (HSSG), Housing	HSSG, Housing

## Summary of risk definition and description

UKCP18 projections for the UK show increases in average summer temperatures and the number of hot days and heatwaves events. Heatwave events are expected to increase in length and intensity, and the heatwave season will increase in length meaning that heat risks may become significant in early summer and spring. The CCRA3 Technical Report suggests:

- That climate change is likely to increase heat-related mortality, heat stroke and heat exhaustion indoors. Projections of heat-related mortality have not been updated since CCRA2, but show that in Wales, heat-related deaths could increase from a baseline of 2.4 per 100,000 people per year now to 6.5 per 100,000 by the 2050s, i.e. over a doubling of risk (central estimates).
- The assessment of current evidence indicates that climate change related risks to health and wellbeing from heat may be higher than previously understood at the time of CCRA2. The 2018 and 2019 heatwaves in parts of the UK revealed a lack of planning in current systems.
- Interactions between risks from high temperatures through combined exposures from air pollution, drought and wildfires are increasingly being recognised as significant.
- A major policy gap across all the UK nations is the lack of inclusion of measures to prevent overheating in Building Regulations and other housing policy.

Response to the risk can result from:

- Public health activities that encourage behavioural change for high risk groups e.g. Public Health Wales early warning approach for extreme weather events.
- Improving design through building regulations and standards for new buildings and increasing incentives for retrofitting. The Welsh Government have proposed introducing a new part of the Building Regulations focused on overheating risk in new build homes as part of a consultation. At the time of writing (April 2021) the Welsh Government are reviewing responses to the consultation.
- Planning guidance for enhancing green space and urban cooling measures, including nature based solutions. Welsh Government is working with Public Health Wales (PHW) to develop extreme weather guidance under [Llwybr Newydd: Wales Transport Strategy](#) 2021 and Area Statements published by Natural Resources Wales are focused on green infrastructure as a means to provide relief from urban heat, as well as other adaptation benefits.
- PHW have [provided some insight](#) into high temperature response through their work on winter health and wellbeing published in 2019. Interviews with stakeholders revealed a need not just to plan for winter, but to also take an approach of continuous preventative planning and long-term planning for increasing incidence of extreme weather events caused by climate change.

The present and future magnitude of this risk is high for Wales, and more action is needed.

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## Benefits of further adaptation action in the next five years

The CCRA3 Technical Report recommends the following to facilitate adaptive management:

- Further action to manage current risks through emergency and contingency planning.
- A legal standard or regulation to address overheating risk for current and future climates at design stage of new build homes or renovations.
- Ensure that passive cooling measures are prioritised over mechanical cooling where a risk of overheating is identified.
- Developing incentives to address overheating in existing homes through retrofitting.
- Continuous preventative planning to include plans for investment in adaptive management approaches and early planning to start preparing for long-term heat risks.

## H2. Health and wellbeing

Health, Communities and the Built Environment					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
OPPORTUNITY	H2. Health and wellbeing	High temperatures	Further Investigation	Health and Social Services	HSSG

### Summary of risk definition and description

The analysis in the CCRA3 Technical Report suggests that climate change is increasingly recognised as a factor that may influence increased recreational use of outdoor space and the natural environment. The analysis suggests that the physical and mental health benefits of increased physical activity and contact with nature are well established, but there is limited evidence on the extent to which a warmer climate will increase these activities. UK summer temperatures are expected to rise with a longer summer season. Possible outcomes of this may be an increase in use of outdoor space for both physical activity, leisure activities, cultural activities, and domestic tourism. These changes could result in:

- Improvements in mental health through use of green and blue space and increased time outdoors may increase Vitamin D exposure. However increased sun exposure has health risks including cancer, immunosuppression and sunburn.
- An increase in physical activity particularly in individuals who have limited access to formal exercise spaces such as gyms and leisure centres due to cost or mobility constraints. Increased active travel such as walking and cycling.
- Public Health Wales has developed a resource to improve access to greenspace and improve health through the built environment: [‘Creating healthier places and spaces for our present and future generations’](#). It does not currently address the implications of future climates.

CCRA3 also points out that even though there is overall warming trend in the UK in the future, including a reduction on cold days and extreme winters, extreme cold seasons are still likely to occur. There is concern that planning for cold risks may become lower prioritised as a risk, and investment and resources will decrease from current levels, thereby increasing vulnerability to such future events. It is therefore important that activities to prevent cold deaths are maintained or strengthened.

### Benefits of further adaptation action in the next five years

The CCRA3 Technical Report recommends the relevant bodies should investigate potential benefits and possible interventions through further investment in strategies to increase physical activity and mental health, factoring in enhanced opportunities for outdoor recreation and active travel due to climate change.

## H3. People, communities and buildings

Health, Communities and the Built Environment					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	H3. People, communities and buildings	Flooding	More action needed	EERA	ESNR

### Summary of risk definition and description

The CCRA3 Technical Report outlines how future river and surface water climate change impacts are a major high level risk and that, despite progress with flood defences, risks are not being managed effectively with an adaptation shortfall which will further require government intervention. Groundwater flooding remains a small proportion of the UK and Wales based risks. The assessment suggests:

- Risks to people, communities and buildings include mortality, physical and mental health impacts, damage to property, financial implications of cleaning up or moving and disruption in terms of access to employment, education, health services and wider facilities.
- Climate change will increase the number of properties at risk of flooding from all sources, and these could be in areas that have not previously been at risk of flooding.
- Flood risk will be exacerbated and locked in unless building within the flood plain is avoided and properties developed in flood risk areas incorporate appropriate resilience measures and sustainable drainage systems (SuDS) design for the lifespan of the development.
- Across Wales there are estimated to be 148,000 people living in areas of significant flood risk from rivers, the sea and surface water (figure 11).
- Expected annual damages from flooding in Wales for residential properties are currently around £94.5million. Flooding in Wales cost an estimated £71 million between November 2011 and March 2014 (figure 11).

	Fluvial	Coastal	Surface Water	All Sources
No. people	46,000	10,000	91,000	148,000
Expected annual damages (£m)	31.6	16.0	46.9	94.5

Figure 11: Present day number of people at significant risk of flooding (top row) and present day expected annual damage residential (direct, £m) (bottom row). (Recreated from Health, Communities and Built Environment technical chapter).

The assessment suggests that although considerable advances have been made regarding the strategic management of flood risk at national and local levels since CCRA2, the risk magnitude remains high now and in the future in Wales, with more action needed due to the scale of the risk. Key areas of challenge relate to continued development on the flood plain, the management of surface water flooding via SuDS, the low take up of Property Flood Resilience (PFR), and the lack of UK-wide standards.

Welsh Government are developing a '[Planning Policy for Wales Technical Advice Note 15: Development Flooding and Coastal; Erosion.](#)' It will produce a new Wales flood map with climate change allowances built in, guide regeneration, development and support risk management authorities on strategic flood consequence assessments.

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## Benefits of further adaptation action in the next five years

The CCRA3 Technical Report recommends the following to facilitate adaptive management which would support current plans, policies and activities:

- Introduction of new metrics focused on reducing social vulnerability to flooding.
- Further requirements on the use of SuDS in development through retrofit.
- More research regarding PFR take up, impacts and future potential in Wales.
- Development of UK and national minimum standards on flood risk as proposed by the UK National Infrastructure Commission.



## H4. Viability of coastal communities

Health, Communities and the Built Environment					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	H4. Viability of coastal communities	Sea level rise	More action needed	EERA	ESNR

### Summary of risk definition and description

This risk is focused on coastal change (physical change to the shoreline caused by coastal erosion, landslip, permanent inundation or accretion) that is of such severity that the long term sustainability and viability of coastal communities is threatened. Viability relates to the future physical existence of a settlement, for example its potential loss from coastal erosion, the future ability for people to live and work in a settlement for example due to safety issues related to flood risk and economic viability wherein the risk of coastal change affects the local economy to such a degree that is no longer viable to invest in the area. The CCRA3 Technical Report has found:

- The upper range for the latest UK sea level rise projections is higher than previous estimates, implying increased coastal flood risk. The likelihood of compound effects from tidal flooding and extreme rainfall is increasing, which can greatly exacerbate flood impact. Just over 10,000 properties are at risk from coastal flooding in Wales at present, and this could increase by up to 260% by the 2080s.
- Future sea level rise will increase the coastal flood and erosion risk and increase exposure (particularly infrastructure) in coastal zones. In Wales 2,126 properties are likely to be at risk of coastal erosion if defences are not maintained, in the next 100 years.
- UKCP18 projections suggest greater sea level rise than had been projected previously (UKCP09). For example, local high water levels that historically occurred once per century (historical in centennial events) are projected to occur at least annually at most locations by 2100 under all [RCP scenarios](#) (high confidence).
- Whilst the threats to the viability of coastal communities are widely recognised and SMPs include policies to support managed realignment (based on UKCP09 data), there is little evidence of national and local governments and other stakeholders taking a strategic approach to identify communities that may be at risk of loss and supporting those communities at risk.
- The increased realisation that it is unrealistic (i.e. prohibitively expensive) to promote a ‘hold the line’ policy for all of the coastline, raises questions of how to: (i) plan our future shoreline on the open coast and along estuaries, and (ii) deliver practical portfolios of adaptation options that are technically feasible, balance costs and benefits, can attract appropriate finance, and are socially acceptable.
- Parts of the west coast of Wales already face risks to their viability as a result of coastal change ([case study 6](#)). Coastal change has particularly severe impacts for vulnerable communities due to the intrinsic deprivation that exists in many coastal areas. CCRA3 highlights the importance of early community and wider stakeholder engagement where the future viability of communities may be threatened.

As communities in Wales are already identified as being at risk, with their long-term viability threatened by sea level rise, the future magnitude score increases from low to medium and then high for both climate futures and more action is needed.

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## Benefits of further adaptation action in the next five years

The CCRA3 Technical Report suggests that to manage this risk, national, regional and local activity is required to identify the communities at risk, recognising where communities may not be sustainable in the long term, and put plans in place to manage the process for these communities, providing clear messages about how the process will be delivered. This will involve strategic, legal, funding, engagement and monitoring commitments.

A thorough review of current governance and delivery should be undertaken to develop a strategic, joined-up approach to managing this issue, including economic and social justice perspectives, rather than the current patchwork of roles, responsibilities, policies and plans. The Technical Report also recommends the following approaches which would also further facilitate adaptive management:

- Establish and maintain a register of properties lost to coastal erosion to provide a more robust on-going record of the impacts of coastal erosion.
- Develop a better understanding of expected annual damages and event losses due to coastal erosion.
- Application of the adaptive pathway approach (or similar) used by the [Thames Estuary 2100 project](#) to plan forward.

### Case Study 6: Fairbourne and Coastal Change

Fairbourne in Gwynedd, north Wales is one of the first communities in the UK whose long term future has been deemed unsustainable due to climate change. Fairbourne is a small community of 461 residential and business properties with a population of around 700 that increases to 3,000 in the summer with the influx of visitors.

Despite defences protecting its estuarine and coastal frontages, rising sea levels as a result of climate change suggest that much of the village of Fairbourne will be below normal high tide levels within the next 50 years. The Shoreline Management Plan (SMP2) policies drawing on UKCP09 projections for 2055 to 2105 indicate that there may be a need for part, if not all of the village, which is currently protected by the estuarine embankment and sea wall, to relocate or disperse elsewhere.



Predictions accompanied by evidence from local monitoring show that by 2054, it will no longer be safe nor sustainable to remain in Fairbourne. However, it is possible that a significant breach in the sea defences could occur before 2054 requiring the relocation of the village. Property blight, financial losses, decline in mental health, loss of community facilities and loss of tourism are all significant impacts which need to be managed.

A multi-agency group was formed in 2013 under the 'Fairbourne: Moving Forward' (FMF) banner including Gwynedd Council, Natural Resources Wales, Arthog Community Council, Welsh Government, Network Rail, Welsh Water, Snowdonia National Park and community groups amongst others. This is supporting the local community and working with stakeholders to develop a planned approach to the decommissioning. Activity has

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included awareness-raising meetings, counselling, a mock evacuation exercise, feasibility studies, workshops, masterplanning, research and the production of Fairbourne Framework for the Future (FFTF) in 2019. Five different approaches were considered over the short, medium and long term with the preferred approach being 'Maintaining Fairbourne's flood defences up to 2054 and the provision of social support to residents over this period'. This plan focuses on the programmed and timely relocation and/or adaption of the community, establishing a Resettlement Plan for residents, investigating 'equity release' for adaptive use and identifying funding need. The overall financial implications of planned relocation are still to be considered alongside the financial impacts on communities in the area.

Welsh Government published a [Fairbourne Coastal Risk Learning Project](#) in 2019 to better understand how to plan for and manage climate change and adaptation elsewhere. This focuses on recommendations for further exploration of the issue, engagement guidance for SMPs, the role of multi-agency Public Services Boards, recognition that multiple plans and strategies are impacted by SMP priorities and that early, progressive and inclusive engagement with communities is of key importance to maintain community cohesion and support health and well-being.

Source: [Infrastructure Technical Chapter](#)

Photo: Natural Resources Wales (permission granted)

## H5. Building fabric

Health, Communities and the Built Environment					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	H5. Building fabric	Moisture, wind and driving rain	Further investigation	EERA and Housing and Local Government	ESNR (non-domestic) and Education and Public Services (EPS) (domestic housing)

### Summary of risk definition and description

The CCRA3 Technical Report considers damage to dwellings from damp, high winds and subsidence due to extreme weather events. The risk is primarily concerned with homes, costs to households and impacts on health and wellbeing. Key climate risks to building fabric include subsidence caused by drought and dry soil, damp or excessive moisture due to flooding, and intense or vertical rain, and structural damage due to high winds. The analysis suggests evidence of the impact of climate hazards on building fabric, particularly the prevalence of current impacts and costs to households, is limited. The magnitude and direction of future changes in the frequency or intensity of the climate hazards is also uncertain. Therefore this risk is evaluated as needing further investigation.

- The analysis provides an overview of areas of concern including
  - Increases in wind driven rain
  - Intensity of rainfall, storm events, and all types of winter rainfall leading to likely increases of water penetration, moisture content of outdoor and indoor air and rainwater ingress.
  - Frequency and intensity of wind storms and the distribution of insured and uninsured losses.
- Building regulations and standards are insufficient to address manage risks from moisture and damp in dwellings.
- It also highlights the likelihood and spatial distribution of subsidence through alteration in soil moisture content and vegetation management (in terms of insurance costs and costs to households). Potential subsidence represents the biggest potential impact.
- Landslides or subsidence linked to past mining activities following periods of heavy rain are another key risk. In Skewen in Wales, flooding from a mine shaft 'blow out' caused by water building up and collapse, [flooded the village](#) following Storm Christoph in 2021.
- Welsh Government recognises the current risks from landslides or subsidence linked to past mining activities following periods of heavy rain. There are over 2,000 coal tips in Wales, predominately in the South Wales Valleys, of which 294 have been identified as high risk. The [Welsh Government statement on coal tip safety](#) highlighted the difficulties in reducing the risk of slope failures near dwellings. Substantial shortcomings in current legislation and the fiscal framework regarding tip inspections and remediation have been identified. Regular inspections of disused tips is not currently mandated, but an approach to risk assessment of coal tips is now being developed. With annual mean rainfall increasing in Wales, especially in South Wales, climate change may increase the risk of future slope failures.
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The Technical Report suggests that there is no evidence that the future risks from climate change in both +2°C and +4°C at 2100 scenarios are integrated into planning, building design or retrofit to date. This lack of long-term policy is likely to be locking-in new developments to some future risk. The present and future risk for Wales is medium.

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## Benefits of further adaptation action in the next five years

The CCRA3 Technical Report discusses the following approaches to facilitate adaptation:

- Improving housing quality has multiple benefits, such as reducing the health and wellbeing burden from damp homes and reducing household costs.
- Most adaptations related to building fabric are currently reactive, i.e. they happen after the damage has occurred to repair the home. There would be benefits to more proactive action to assess risks, including measurement of indoor environmental quality and better prediction of risks like subsidence. This would include factoring in the possible impact of climate risks based on +2°C and +4°C at 2100 scenarios into planning, building design and retrofit.
- Measures to improve energy efficiency in new and existing housing, such as increased insulation and airtightness can lead to increased risk of moisture-related damage to building structure and the internal environment if additional ventilation is not also included. Taking a more integrated approach to design for new builds and retrofit will have multiple benefits, not least to avoid issues like higher indoor vapour and mould growth.
- An important response to windstorm risks is household insurance. Retrofit interventions to existing homes like stronger doors and windows have high up-front costs but also high benefits. New builds would benefit from more consideration of siting, orientation, design and materials used in advance of construction to reduce the risks from wind.

## H6. Household energy demand

Health, Communities and the Built Environment					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK & OPPORTUNITY	H6. Household energy demand	Summer and winter temperature changes	More action needed	EERA & Housing and Local Government	ESNR (Warm Homes Programme and Fuel Poverty) and EPS

### Summary of risk definition and description

The CCRA3 Technical Report emphasises the potential positive economic benefit of climate change in the UK of reducing heating demand and positive impacts on fuel poverty. It suggests that future climate change will reduce heating demand with benefits across all future periods and scenarios for Wales. At the same time, there will be higher temperatures in summer with climate change, which will increase cooling degree days and the potential need for mechanical cooling. In addition:

- Using the [2050 DECC pathways tool](#), based on a 50% probability (UKCP09 scenario), heating demand will be reduced by ~20% under seasonal normal conditions by 2050.
- The future level of benefit is uncertain, and depends on socioeconomic change and also the potential rebound effect (reduction in energy bills frees up funds which can be spent on energy, or on other goods and services that lead to GHG emissions).
- A range of evidence is cited exploring factors which will influence changes in demand. For example, heatwave events can act as a catalyst for a major uptake of air conditioning locking in much higher demand. Evidence suggests that increases in electricity demand for cooling will be less than the reduction in demand for heating.
- These changes will drive the relative energy demand in winter versus summer, which has important implications for electricity generation as well as gas supply, storage and transmission.
- The combination of falling winter heating demand and increasing summer cooling demand does not appear to be tackled in an integrated and systematic way in policy.
- Current approaches to Net Zero do not assess the impact of warmer temperatures from climate change, or cooling demand on the achievability of the target for household energy demand.
- The opportunities from reduced heating costs are not being fully realised, i.e. there is insufficient action being undertaken to understand and take advantage of the future warmer climate.

Welsh Government's [Prosperity For All: A Low Carbon Wales](#) (2019) sets the context for energy policy in Wales going forward and identifies that the need for cooling is projected to increase and should also be considered as part of future energy demand. However, this strategy does not factor in falling heating degree days.

The present and 2050 magnitude scores for the risk of increased summer cooling is low in Wales but increasing to medium in 2080 under high emission scenarios. However, confidence is low and there could be higher magnitudes under warmer scenarios. The magnitude of the benefit of reduced in winter heating costs is high across all future periods and scenarios, and more action is needed.

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## Benefits of further adaptation action in the next five years

CCRA3 recommends the following actions to facilitate adaptive management:

- Policies and strategies for space heating and cooling in dwellings would be more successful if they include consideration of the changing climate and its effect on energy demand in homes alongside the need to decarbonise. There is a need for better integration of this issue in Net Zero policy analysis, and subsequent government intervention. Information and awareness raising to help households and businesses to recognise and maximise these beneficial changes would help realise the potential economic benefits.
- This risk/opportunity has been highlighted in the risk assessment as particularly likely to benefit from an ‘adaptive pathway’ approach, meaning various policy choices are mapped out against different future climate change and Net Zero scenarios, and the choices are narrowed down over time as uncertainty decreases. Adaptive pathways are used routinely in the flooding and water sectors, but to date have not been used widely in energy policy.
- There is also a need to build increased cooling demand into energy policy, including:
  - Incorporating future changes in energy demand from warmer winter and hotter summers into energy efficiency and low carbon heating policy and technologies being rolled out across the UK.
  - Incentivising the uptake of passive cooling over mechanical cooling measures as far as is appropriate.
  - Providing support households that might experience ‘summer fuel poverty,’ for example by an inability to afford air conditioning if this is required.

## H7. Health and wellbeing

Health, Communities and the Built Environment					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	H7. Health and wellbeing	Changes in indoor and outdoor air quality	Further investigation	Health and Social Services & EERA	HSSG & ESNR

### Summary of risk definition and description

The CCRA3 Technical Report describes how outdoor air pollution has both anthropogenic causes (emissions from transport and industry) and natural sources (dust, pollen, mould, and pollutants from wildfires). This is already considered to be a high magnitude risk across the UK. Weather conditions can exacerbate and prolong periods of low air quality. Risks to health from outdoor pollution are particulates (PM2.5 and PM10), though [ground level ozone](#) also affects health but levels have declined in recent decades. CCRA3 suggests that:

- Climate change is expected to affect outdoor air quality in both urban and rural areas by directly and indirectly modifying ground level ozone concentrations.
- Higher temperatures may trigger regional feedbacks during stagnation episodes (still weather) that will increase peak ground level ozone.
- Changes in temperature and wind speed will affect local pollution levels. In areas with high Nitrogen Oxide levels, warming is likely to trigger feedbacks in local chemistry and emissions, increasing levels of ozone.
- Pollen risks are expected to change with climate change although the implications for health are not clear. CCRA3 analysis considers evidence linking allergic responses and thunderstorms during pollen seasons and air pollutant and allergenic pollen exposure interaction.
- Studies do not model weather patterns such as blocking episodes or stagnation episodes, but use average annual temperatures. There may be an increase in pollution episodes associated with weather patterns, even if the general trend indicates that air quality is improving.
- Wildfire risks may increase due to projected changes in temperature and rainfall (hot and dry weather). It is likely that the frequency of moorland, grassland and forest fires may increase with regional differences. Forest fires emit particulate matter and toxic products and create extensive and long-lasting air pollution events.
- There is little evidence for the impact of climate change on indoor air quality. Impact is dependent on building characteristics, ventilation, emissions from indoor sources and external air quality.
- The future level of risk in terms of annual mortality from climatic factors *alone* is projected to be small except under high rates of warming, and high rates of pre-cursor emissions.

Welsh Government published [The Clean Air Plan for Wales, Healthy Air, Healthy Wales](#) in August 2020. This Plan sets out a 10 year pathway to achieving cleaner air. The timescales for delivering actions are framed within three Senedd periods, short term: 2020 to 2021, medium term: 2021-26 and longer term: 2026-2031. This plan includes actions to increase the role of nature-based solutions such as tree planting to improve air quality under climate change.

Scoring this future risk is difficult as the magnitude of outdoor air pollution impacts on health, wellbeing and health costs is very high. However, the role of climate hazards per se is rather small and uncertain. Present-day risks are scored from both climate and non-climatic factors and are therefore scored as high magnitude due to the high number of annual deaths attributed to outdoor air pollutants. Future level of risk for Wales is scored as a medium with further investigation needed. There is an overall lack of uncertainty in terms of which future emission and climate pathways will occur, so this risk has a low future confidence.



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## Benefits of further adaptation action in the next five years

The CCRA3 Technical Report recommends the following activities to facilitate adaptive management:

- Research into the following areas to inform adaptation policy: wildfire; pollen risks; changing wind patterns and blocking episodes; interactions between air pollutants and heat exposure work on improved early warning and response plans for extreme events, notably where there is an interaction between heat and air quality.
- Ensuring climate risks are integrated into air quality improvement measures in air quality plans.
- Considering health co-benefits and trade-offs of potential adaptation actions for air quality may be helpful, for example nature-based solutions and improving green spaces.
- Update of existing ventilation standards, for example building regulations, or development of new standards for indoor air quality. Welsh Government are currently reviewing Part F of the Building Regulations, which covers ventilation standards.

## H8. Health

Health, Communities and the Built Environment					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	H8. Health	Vector-borne disease	Further investigation	Health and Social Services & EERA	HSSG & ESNR

### Summary of risk definition and description

Analysis in the CCRA3 Technical Report outlines how diseases transmitted by arthropod vectors (insects and ticks) are sensitive to temperature and that there have been changes in observed distributions and seasonal activity of vectors since 2016. Climate change may impact on vector-borne disease through tick-borne diseases from Lyme disease, mosquitoes (*Aedes*) and *Culex* transmitted diseases. CCRA3 suggest that:

- [Lyme disease](#) cases may increase with climate change due to an extended transmission season and increases in person-tick contact. There are about 20 species of tick that are endemic in the UK with the sheep, castor bean or deer tick (*Ixodes ricinus*) most likely to bite humans.
- It may well be the indirect effects of climate change on recreational activities (for example increased outdoor tourism) or other non-climate drivers (such as changes to land use and wild animal populations) that are more important drivers of transmission.
- The risk of mosquito and culex transmitted diseases is likely to increase in the UK through longer transmission seasons.
- The risk that malaria may become established remains low.
- There is a major risk of lock-in for vectors and pathogens. Once introduced, it extremely difficult for a zoonotic pathogen to be eradicated.
- Exit from the EU may undermine actions to control vector-borne diseases through reduced access to international surveillance systems. However, at the time of writing, it not known whether the UK will have continued access to international public health surveillance systems such as those coordinated by the European Centre for Disease Prevention and Control (ECDC).

[Prosperity for All: A Climate Conscious Wales](#) (2019) includes actions to increase monitoring at ports and airports, and efforts to increase understanding of the risk, particularly from Lyme disease, with healthcare professionals. The plan commits to research what other action is needed and to survey where vectors are entering Wales in the future.

The Public Health Wales [Communicable Disease Surveillance Centre \(CDSC\)](#) is the epidemiological investigation arm of the National Public Health Service for Wales. It aims to protect the population from infection through surveillance of infectious disease, support for outbreak investigation, provision of health intelligence and applied research. It is unclear how far the Centre has taken forward work to address any increased risk in vector-borne diseases from climate change.

In Wales, the current risk magnitude is considered medium, becoming high in the 2080s due to projected increases in temperatures and therefore an increased risk of the *Aedes albopictus* mosquito becoming established.

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## Benefits of further adaptation action in the next five years

The CCRA3 Technical Report recommends the following:

- There would be direct benefits from improving disease and vector surveillance in Wales and across the UK, given the very large benefits of catching vectors and pathogens before they become established.
- The main benefits of further action are in enhanced monitoring and surveillance systems, including early warning, which can be considered a low-regret option. Surveillance programs are highly cost effective.
- There are also studies that show that vaccination for [tick-borne encephalitis](#) may be cost-effective, for people who may be exposed through work, although there is currently no vaccine for Lyme disease.

## H9. Food safety and food security

Health, Communities and the Built Environment					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	H9. Food safety and food security	Higher temperatures (food safety) and extreme weather (food security)	Further investigation	EERA	ESNR

### Summary of risk definition and description

The CCRA3 Technical Report suggests that climate change is likely to be important risk for food safety in the UK through a range of pathways, as increases in extreme weather patterns, variations in rainfall and changing annual temperatures will impact on the occurrence and persistence of bacteria, viruses, parasites, harmful algae, fungi and their vectors. CCRA3 has found that there is currently limited UK research on quantifying future risks to food safety from climate-related events.

Evidence is examined on bacterial pathogens, chemical contamination, food safety in fish and shellfish and mycotoxins and the role of key organisations on food safety across the UK.

There is currently no specific policy which addresses climate change risks to food safety.

The analysis also focuses on aspects of food security examining evidence related to the health effects of impacts on imports, shocks to the international food system such as multiple harvest failures, produce availability, food poverty and the social and health costs of poor food and equity of food distribution, concluding that:

- A key risk will be variability in access to food due to disruptions to the supply chain from arising weather events and climate hazards.
- UK food policy experts are concerned about the fragility of the UK food system due to reliance on international markets which has been further stressed by Brexit and restrictions to the market.

Some of these issues are also picked up in risk [ID1](#) on food availability from international trade.

In Wales, WWF Cymru [commissioned research](#) from the Cardiff University Sustainable Places Research Institute which recommends a new approach to the food system in Wales based on agroecology, localisation of the food systems, restoring environmental, social and human capital to strengthen food security in response to climate change and other key drivers.

The magnitude of future risk is high, hence further investigation is required.

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## Benefits of further adaptation action in the next five years

The CCRA3 Technical Report recommends the following to facilitate adaptive management:

- For food safety, regulations and education on food handling and safety, coupled with horizon scanning and continuous monitoring for emerging risks.
- Outline monitoring of food security across the UK is essential to protect public health and limit unnecessary costs for the health and social care system.
- Predicting future climate risks to the UK food system to ensure vulnerable groups to food insecurity are protected and the impacts to public health are minimised.

## H10. Health

Health, Communities and the Built Environment					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	H10. Health	Poor water quality and household water supply	Further investigation	EERA & HSSG	ESNR

### Summary of risk definition and description

The CCRA3 Technical Report describes different pathways by which climate change may affect health and wellbeing through changes in water quality (drinking water or bathing water) and water availability (in the household). Analysis focuses on risks to individuals, families and communities and the consequences of interruptions in household water supply for public health and wellbeing. Risks for water companies and related infrastructure are addressed in detail in risk [18](#).

CCRA3 broadly outlines current and future risks including the impact heavy rainfall on runoff into rivers and lakes washing sediment, nutrients, pollutants, rubbish, animal waste, and other materials into water supplies. High temperature and low flow can cause increased concentrations of pollutants and algal blooms. It also outlines current adaptation approaches from both supply companies and regulators through Water Resources Management Plans and other regulations. The [Drinking Water Inspectorate](#) (DWI) indicated that adverse weather is one of the biggest risks to discolouration and interruptions public water supplies in Wales. Private water supplies are particularly vulnerable to quality issues and supply interruptions. There are a relatively high proportion of private supplies in Wales with 13,880 supplies supporting 71,000 people at home or work. There have not been any droughts in Wales that have had implications for household water supply since 1976 although low rainfall in spring 2020 led to the updating of drought plans in some areas, such as for the River Severn.

Particular concerns related to future risks which need to be addressed in addition to current adaptation approaches include:

- Contamination of private water supplies and increased vulnerability to dry, warmer weather.
- Risks to health from contact with bathing water (sea, lakes and rivers) and harmful algal blooms.
- Damage to industrial infrastructure leading to a chemical release and emergency planning for chemical incidents during flooding.
- Flooding of contaminated land and historical landfill sites, related to dispersed pollution.
- Indirect impact of cascades from power and IT disruptions affecting water infrastructure.

Natural Resources Wales is the regulatory body responsible for managing water resources in Wales. They provide oversight of both bathing and drinking water through a wide range of strategies, plans and regulatory activity. Water companies also report annually on bathing water quality in Wales. Water Health Partnership for Wales is an initiative that brings together relevant agencies to work together more effectively to protect public health by ensuring the provision of safe drinking water. Agencies in the Partnership include the DWI, Welsh Government, local authority public and environmental health, the water companies and Public Health Wales.

Dwr Cymru/Welsh Water in their [2019 Water Resources Management Plan](#) focus on catchment level interventions to maintain or improve the water quality available. It abstracts from 120 catchments covering an area of almost 11,000km<sup>2</sup>. This approach is called their [Watersource](#) initiative. Dwr Cymru estimate the most likely impact of climate change upon their supply capability through a vulnerability assessment; and calculation of river flows for water

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resource zones up to the 2080s. This identifies five areas which they believe have high vulnerability when climate change is factored in including Barmouth, North Eryri Ynys Mon (NEYM), Pembrokeshire, South East Wales Conjunctive Use System (SEWCUS), and Tywyn Aberdyfi.

The risk is assessed as being low-medium magnitude at present rising to medium in future, and further investigation is required

## **Benefits of further adaptation action in the next five years**

The CCRA3 Technical Report recommends the following to facilitate adaptive management to address the concerns listed above:

- Further research is needed on the likelihood and impacts of multiple hazards from climate change impacting on water quality and supply, and the effects of droughts and household water supply interruptions on human health and wellbeing.
- Further implementation is needed through interventions which are designed to prevent flooding including development of SuDS, catchment management, wetland creation and nature based solutions.
- Activities to protect private water supplies particularly for rural communities.

## H11. Cultural Heritage

Health, Communities and the Built Environment					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	H11. Cultural Heritage	Changes in temperature, precipitation, groundwater, land, ocean and coastal change	More action needed	Culture, Sport and Tourism	ESNR

### Summary of risk definition and description

The analysis of risks to cultural heritage in the CCRA3 Technical Report focuses on moveable heritage (museum collections and archives), archaeological resources, buildings and structures, cultural landscapes and associated communities, marine heritage and intangible heritage (folklore, traditions, language, knowledge and practices). Climate impacts that affect heritage assets may have knock on effects upon other sectors – including tourism, health and wellbeing, and natural environment and vice versa. The analysis suggests that:

- Since CCRA2 there has been an increase in research on the mechanisms by which climate hazards currently affect heritage.
- Heritage organisations have undertaken assessments to scope the risk to assets and there is increasing evidence that there are a large number of heritage assets at risk.
- Coastal heritage is particularly at risk from climate change and heritage organisations and communities will need to accept the loss of some heritage assets, particularly in coastal areas.
- Climate change projections predicting increasing temperature, humidity, intense rainfall, drought, flooding and coastal erosion means it is likely that this risk will remain high into the future.
- Continued monitoring is essential to inform risk management, especially for coastal sites.
- Flood protection measures may do damage if not done appropriately (risk of harm).
- Opportunities from climate change are evident, for example new heritage discoveries revealed by climate impacts.
- Lock-in risks are high in the sense that most heritage assets are not moveable, with particular relevance for the many heritage assets located along the UK's coastline.
- For Wales, the Historic Environment and Climate Change in Wales Sector Adaptation Plan ([insight 2](#)) concluded that a large number of assets in Wales are at moderate risk from a wide range of climate hazards. Cumulatively, these risks were identified to be of high significance. Historic landscapes are particularly vulnerable as the cumulative loss of historic assets may affect the integrity and survival of the historic landscape as a whole. Heritage assets in Wales have been mapped against LiDAR, flood risk data and intertidal data to better understand the risks from climate change.

The risk magnitude for Wales is medium at present. In Wales 12% of Scheduled Monuments and 12% Listed Buildings are in Flood Zone 3 and numerous nationally important coastal hillforts are at risk of erosion. With climate change, these current risks are only likely to increase with others emerging that have not yet been identified, therefore risk is assessed as rising to high in the future. Confidence levels are higher for Wales due to more activity in the sector.



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## Benefits of further adaptation action in the next five years

The CCRA3 Technical Report recommends the following activity to facilitate adaptive management:

- Longer-term data capture and mapping to understand the vulnerability of different heritage assets to identify assets and locations that are most at risk.
- Monitoring and surveillance for particularly sensitive sites in order to recommend both preventative and remedial action.
- Developing more robust systems of prioritising assets for action.
- Communicating the emerging prominence of ‘managing loss’ of heritage assets to facilitate action.
- Improving technical understanding of impacts on assets from ocean chemistry, changing rates of erosion, ground conditions, and repeated or prolonged flooding as well as understanding the combined impacts of climate drivers on assets (sea level rise, storminess, wind driven rain, storm surges).

### Insight 2: Historic Environment adaptation plan

Wales Historic Environment Group published a sector specific adaptation plan in February 2020. Key actions focus on: knowledge exchange and collaboration; mapping and monitoring heritage assets, sites and landscapes; identification of research priorities; dissemination, promotion and collaboration; training and guidance; developing adaptation plans and work programmes for vulnerable areas assets at risk; establishing stakeholder/community groups and developing new planting regimes.

Source: [Welsh Government](#)

Image: *Carew Castle & Tidal Mill Ponds, Pembrokeshire (Unsplash)*



## H12. Health and social care delivery

Health, Communities and the Built Environment					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	H12. Health and social care delivery	Extreme weather	More action needed	Health and Social Services	HSSG

### Summary of risk definition and description

Climate change will potentially disrupt health and social care services due to both the direct effects of floods, heatwaves and other extreme weather on hospitals and other health and care settings, which may damage buildings or disrupt the ICT and transport infrastructure upon which services rely, and indirectly, through the detrimental effects of extreme weather on people's health and wellbeing, which increase demand for services. These impacts may be felt not only within institutional settings such as hospitals, residential and nursing homes for older people, or respite centres for disabled people, but will also affect people who receive social care services in their own homes, and may prevent people from accessing critical services such as GPs. The CCRA3 Technical Report analysis provides the following observations on this risk:

- The current and future flood risk of health system assets including hospitals, care homes, GP surgeries and emergency services has been assessed for Wales and other parts of the UK. This shows climate projections to the 2050s and 2080s under both low and high emissions scenario. This analysis shows an increase in the number of emergency services assets and care homes at flood risk under all scenarios; with smaller increases for GPs surgeries and hospitals (figure 12).
- To avoid lock-in, there is a need to ensure new hospitals and care settings are designed for the future climate. Consideration of future pathways (and adaptive management) would support this to ensure planning considers appropriate interventions for both +2 or +4°C at 2100 scenarios.
- For health and social care providers important factors include the resilience of physical assets and varied care settings (in the context of differing risks from heat, drought, storms, floods) and ensuring institutional policies and operating practices are responsive to changing needs (for example, adjusting daily routines and management and operating practices in care homes to mediate risk in care settings during heatwaves).
- Cascading risks from power and IT outages and disruption to transport infrastructure (for example roads being flooded) can cause transport delays and impact on this risk.
- There is still relatively little published evidence on the evaluation of emergency planning in hospital and other health care settings to inform future planning.
- There is an adaptation gap illustrated by a lack of action at the national and local levels across the UK to implement strategies to address climate risks to health and social care
- The Welsh Government and NHS Wales have made progress in increasing resilience to extreme weather. [A Building Note](#) (Welsh Government, 2017) focuses on the strategic approach to resilience planning for healthcare estates, procurement, design and planning, building services and engineering. This focuses on impacts of severe weather incidents, flood risk, coastal change, water supply and changes to biodiversity and landscape and wildfires. This is a comprehensive tool for managing the estate and assets. The extent of implementation and influence is not understood, although reference to it does not feature in elements of health and social care planning in Wales.

Population Proj	Present	2050s				2080s			
		Low		High		Low		High	
		2°C	4°C	2°C	4°C	2°C	4°C	2°C	4°C
<b>WALES</b>									
Emergency services	81	98 (99-98)	105 (109-106)	100 (101-100)	107 (112-108)	103 (104-103)	120 (127-121)	107 (108-108)	126 (133-127)
GPs surgeries	51	55 (55-55)	59 (60-59)	56 (56-56)	60 (61-60)	57 (57-57)	69 (72-70)	59 (60-60)	73 (75-73)
Hospitals	16	17 (17-17)	17 (17-17)	17 (17-17)	18 (18-18)	17 (17-17)	18 (18-18)	18 (18-18)	20 (20-20)
Care homes	48	71 (71-71)	78 (79-78)	73 (73-73)	80 (82-80)	76 (76-77)	87 (90-87)	81 (81-81)	93 (96-94)

Figure 12: Current and future flood risks for health and social care assets in Wales (Recreated from Health, Communities and Built Environment technical chapter).

Due to the number of assets at risk of overheating and from flooding, the magnitude of risk is currently medium for Wales, with a medium level of confidence, rising to high in the 2080s due to increasing temperatures. It is assessed as more action is needed

## Benefits of further adaptation action in the next five years

The CCRA3 Technical Report recommends the following activity to facilitate adaptive management:

- This risk needs to be managed strategically at a national level in Wales (and other areas in the UK). Regional and local level climate risk assessments carried out by Health Boards and local government social services would help them plan forward with climate risks in mind.
- There are potential benefits from ensuring new care homes and hospitals are designed for the future climate in terms of both flood risk and future temperatures, which is particularly important given the higher costs of retrofitting later.
- There are also potential options for retrofitting existing care homes and hospitals.
- Adaptations through design insights from case studies where heatwaves have been experienced and tackled should be made readily available to those involved in the design, management and use of care homes. Indicators and monitoring methods to track adaptation actions and resilience across the health and social care sector and reporting on preparedness of this sector to climate change.

## H13. Delivery of education and prison services

Health, Communities and the Built Environment					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	H13. Delivery of education and prison services	Extreme weather	More action needed	Education	EPS

### Summary of risk definition and description

The CCRA3 Technical Report covers the climate-related risks to all aspects of the education sector (schools, universities, nurseries and other early years settings) and justice services (prisons, courts, and secure units). This risk was not addressed in CCRA2 and is an emerging area of concern. The analysis suggests for *education services* that the majority of current evidence on climate risks and education relates to the impact of current overheating in schools, with associated health, performance and productivity impacts. Regulation of temperature, high classroom occupancy, the volume of IT equipment and design limitations of both new and old school buildings are key factors to consider going forward.

Projections of future flood risk in the UK indicates that number of schools located in the highest flood probability category by 2080 will increase by 32% and 95% for +2°C and +4°C at 2100 scenarios respectively, assuming no change in adaptation and no further population growth. Further analysis shows increases in significant probability of flooding for Welsh Schools in figure 13.

Population Projection	Present	2050s				2080s			
		Low		High		Low		High	
		2°C	4°C	2°C	4°C	2°C	4°C	2°C	4°C
<b>WALES (Total = 1,569)</b>									
Schools	51	58 (59-58)	62 (63-63)	59 (60-59)	64 (64-64)	62 (63-62)	73 (74-74)	64 (65-65)	76 (77-77)

Figure 13: Flood risks to schools – current risk and future projections by devolved administration (taken from Health, Communities and Built Environment technical chapter).

Welsh Government's Education Wales has produced a [21st Century Schools and Education Funding Programme Guide](#) (2018) which aims to make schools and educational facilities sustainable. This document provides material for those involved (including client and design teams) to consider climate change readiness including flood risk, overheating, energy, water, whole life costing, drainage and landscape issues. Checklists and narrative are provided.

The analysis for prison services suggests:

- There is limited published evidence of the impact of climate hazards on prison buildings and inmate and staff health in the UK. Risks to prisons from climate change include overheating, flooding and building damage. Improved adaptation and emergency planning procedures will be required.

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- The Ministry of Justice have published a climate change strategy which highlights the key risks to prisons across the England and Wales. Flooding, storms and drought are indicated due to the risk of loss of building use and increased financial costs of repair or finding alternative accommodation for inmates.
  - Evidence from the US highlights the impact climate change and natural disasters have had on vulnerable populations and may be important considerations for the UK including power outages, food supply, water shortages from severe weather and inmate mortality from heat related deaths.
  - The HM Inspectorate of Prisons report included concerns from inmates during inspections which included difficulty of breathing, continuous heating, high ambient temperatures in cells and limited oxygen from poor ventilation. Ministry of Justice (MoJ) received nearly 500 reports and complaints of overheating in Lack of heating (too cold rooms) is has been recognised as a problem in several prisons in the UK. Currently, there is no systematic evidence monitoring the indoor temperatures inside prisons in the UK.
  - There are five prisons in Wales; Berwyn (a Category C in Wrexham), Usk (Category C) which includes Prescoed (Category D), Cardiff (Category B), men's prison Parc in Bridgend (privatised and run by G4S) and Swansea (Category B/C). Her Majesty's Prison and Probation Service (HMPPS) in Wales, the Welsh Government, Local Health Boards and Public Health Wales developed a [Partnership Agreement on prison health in Wales](#). This sets out the mechanism for a Shared Priorities Delivery Plan process through to 2023.

## Benefits of further adaptation action in the next five years

The CCRA3 Technical Report recommends the following to facilitate adaptive management in **education services**:

- Long-term climate adaptation planning and response strategies to address the shortfall in adaptation planning education services.
- Avoiding lock-in with building designs to adapt to the future risks of overheating, flooding and other climate hazards
- Implementation of design features in school buildings including modifications to reduce ambient temperatures, conserve water and provide ventilation and increasing shade and flood water management in school grounds.

The CCRA3 Technical Report recommends the following to facilitate adaptive management in **prison services**:

- The CCRA3 Technical Report recommends implementation of the recent [Ministry of Justice's Adaptation Plan](#) (2020) which requires that sites assess risks and use this assessment to inform adaptation plans/actions.

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## 7. Business and Industry



*Cardiff Capital Region: Unsplash*

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The CCRA3 Technical Report examined the evidence of climate change impacts organised across seven identified key risks to business and industry within the UK<sup>5</sup> covering: flooding to businesses and infrastructure, water scarcity, access to finance, investment and insurance; employee productivity, supply chains and distribution networks; and changes to demand in goods and services. This section provides:

- A summary and description of each risk to business and industry.
- Suggestions from CCRA3 on the benefits of further adaptation over the next five years.

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<sup>5</sup> A key source of risk for many UK businesses is the result of climate change outside the UK which affects UK businesses through investments, supply chains, distribution networks and other business relationships. Technical [Chapter 7](#) explores international risk in more detail.



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The analysis provided some broad observations on the relationship between business and industry and climate risk that can be summarised as follows:

- There is a disconnect between understanding and responding to current climate variability as compared with future climate change. Current adaptation actions such as business continuity efforts, may not be sufficient for future risk levels.
- Business decisions can ‘lock in’ to future climate risk that may be irreversible or costly to revert later. This can occur through businesses decisions on operating models, site locations, infrastructure, supply chains, technologies, policies or pre-existing adaptation actions, which may increase exposure to long-term risks.
- There are some early indications that some businesses are looking at potential opportunities from climate change with some examples for goods and services, but consideration of possible benefits remains largely unexplored.
- Overall awareness of adaptation as a business issue is low compared to awareness of mitigation.
- Economic development and industrial strategies need to consider climate risk and adaptation as drivers of economic policy.
- The vulnerability of natural capital to climate impacts creates significant risks for businesses, and for the goods and services they provide. This needs greater acknowledgement and response from the business and industry sectors.

Thinking has developed in CCRA3 related to cascading risks suggesting that any risk has the potential to have a propagating impact across the network, or indeed other networks via cascade failure e.g. energy supply and transport network failure, the consequences of which have far reaching social and economic disruption beyond the impact itself. CCRA3 has also identified lock-in risks, for example, the reliance on the electricity network which has itself been identified as having an adaptation shortfall.

The Assessment was supported through provision of the Welsh policy context, including information from:

- National strategy and planning: [Prosperity for All: Economic Action Plan](#) and Economy Futures Fund; [Future Wales: The National Plan 2040](#) (2021), [Wales Infrastructure Plan](#) (2019), [Llwybr Newydd: Wales Transport Strategy 2021](#), commitments in Welsh Governments’ [Prosperity for All: A Low Carbon Wales](#) (2019), [Prosperity for All: A Climate Conscious Wales](#) (2019), [Wales Flood & Coastal Erosion Risk Management Plan](#) (2021), [Marine Plan](#) (2019), and [Sustainable Farming & Our Land](#) (2020).
- Area based plans: Water Resource Management Plans, Shoreline Management Plans, River Basin Management Plans, Local Resilience Plans and work by NRW on Area Statements.
- The plans of key groups and organisations: [Wales National Infrastructure Commission](#), [Wales Resilience Forum](#), [Wales Pension Partnership](#) and the [Development Bank for Wales](#).

References to the Welsh policy context are made throughout this section.

The analysis provides a number of broad suggestions to facilitate adaptive management for business and industry that are particularly applicable to all risks:

- Appraisal of effectiveness of adaptation action and government policy in influencing or creating the enabling environment or incentives for business adaptation.
- More systematic and comparable assessments of hazard, exposure and vulnerability to ensure comparability across risks, sectors and regions.
- Modelling of infrastructure disruption on the productivity of particular economic sectors to support better visualisation of geographical variation.
- Better understanding of the barriers and constraints to private sector adaptation.
- Assessment of the effects of Net Zero including the synergies or trade-offs (including potential maladaptation) to climate risks and opportunities.
- Considering lessons learned and interdependencies from the COVID-19 pandemic.

Most of the urgency scores related to business have increased in relation to those in CCRA2. This partly reflects an improved ability to assess and report these risks, but it also reflects that business decisions continue to create additional risk by locking in increased exposure and vulnerability.

Risk	CCRA2 urgency scoring	CCRA3 urgency scoring
B1: Risks to businesses from flooding	Research priority	More action needed
B2: Risks to business locations and infrastructure from coastal change	Research priority	More action needed
B3: Risks to businesses from water scarcity	Sustain current action	Further investigation
B4: Risks to finance, investment and insurance including access to capital for businesses	Watching Brief	Sustain current action
B6: Risks to business from disruption to supply chains and distribution networks	Sustain current action	More action needed
B7: Opportunities for business from changes in demand for goods and services	Watching Brief	Further investigation

There follows a summary of all climate risks and opportunities in Wales related to businesses.



## B1. Flooding of business sites

Business and Industry					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	B1. Flooding of business sites	Increase in flood risk	More action needed	Economy, Transport and North Wales	ESNR

### Summary of risk definition and description

As noted in previous sections of this Summary, the CCRA3 Technical Report suggests that future river and surface water flooding from climate change impacts are a major high-level risk and that despite progress with flood defences, risks are not being managed effectively with an adaptation shortfall, which will require further government intervention. The assessment suggests the key risks to businesses are mortality, physical and mental health, damage to property, financial implications of cleaning up or moving and disruption in terms of access to employment, education, health services and wider facilities. For businesses specifically, the key concerns are as follows:

Climate change will increase the number of business and industry properties at risk of flooding from all sources and these could be in areas that have not previously been at risk of flooding. A CCRA3 commissioned report on future flood projections assesses the impact of three different adaptation portfolios on future risk to non residential properties: continued level of adaptation, reduced whole system and enhanced whole system. Figure 14 shows scenarios for a reduced whole system approach, showing levels of risk to Wales in 2050 and 2080. Sayers et al. (2020) report that the expected direct annual damages for non-residential properties in Wales at present is £51m, comprising of 8% of total UK damages.

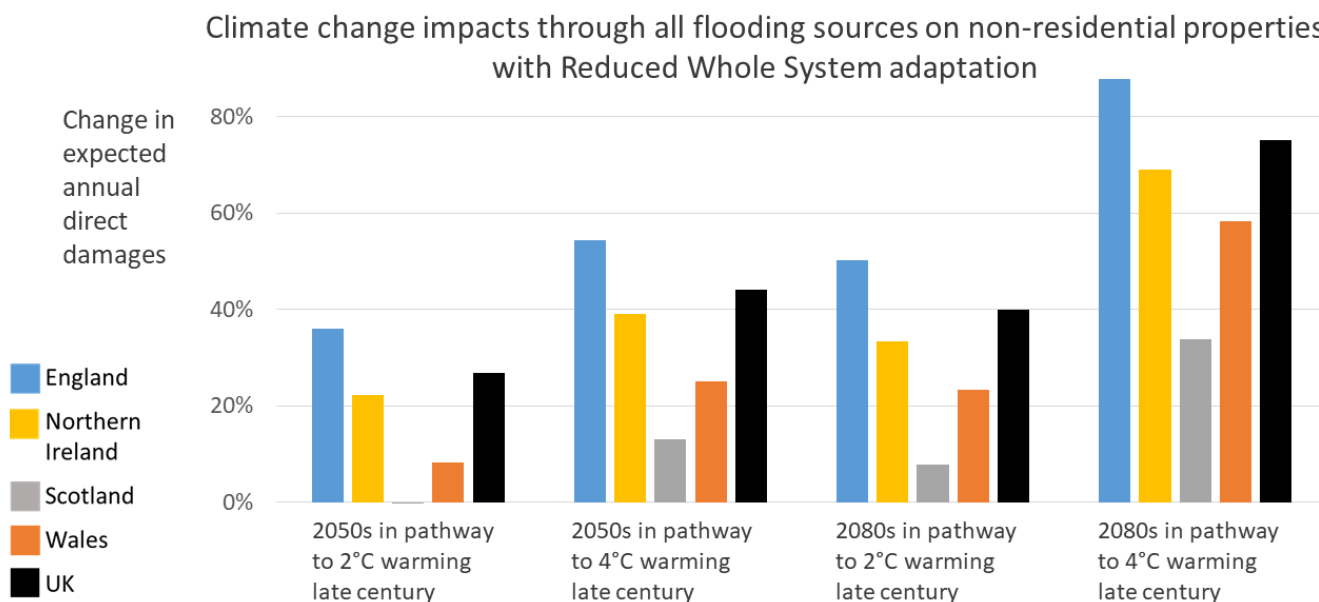


Figure 14: Future risks; percentage change in expected annual damages to non-residential properties for a +2oC and +4oC at 2100 scenario, all sources of flooding, direct, £millions. (Taken from Business and Industry technical chapter).

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Given the expected annual impacts identified by Sayers et al. 2020 – (in the tens of millions for Wales) the magnitude of this risk is high now and in the future. This is also supported by other evidence. Flood risk to businesses will be exacerbated and locked in unless building within the flood plain is avoided and properties developed in flood risk areas incorporate appropriate resilience measures and SuDS design for the lifespan of the development.

[Wales River Basin Management Plans](#) for western Wales; Severn and Dee rivers and 11 catchment summaries focus on climate risks to soils, water, trees, biodiversity, water demand and supply and character. Data is available from River Basin Preliminary Flood Risk Reports. Businesses come under a category of non-residential properties along with public buildings. Data available for potential non-residential properties at risk from flooding with climate change allowances for river, sea, surface flooding factored in are 870 for the Dee, 4,795 for the Severn, and 5,180 in western Wales. Infrastructure sites relied on by local businesses in these catchments at risk are 341 for the Dee, 1,658 for the Severn and 1,658 in western Wales.

The CCRA3 analysis focuses on the following factors that may influence risk management for business and industry:

- That business action is mostly concerned with responding to current risk levels, rather than on future resilience.
- Business investment decisions have a high potential for lock-in for this risk because of the location of investment and the rising risks of flooding.
- Evidence suggest that businesses have an over-reliance on hard engineering solutions which can skew adaptation efforts away from more holistic approaches such as ecosystem services.
- A number of risks have been identified related to flooding of non-residential properties cascading through into other risks. The most significant of these pathways for businesses included flooding affecting power infrastructure, water and sewage infrastructure, transport hubs, and flooded buildings leading to productivity losses.
- Individual businesses need to assess their basic infrastructure services like power and water and transport alongside direct business impacts.
- Confusion exists about risk ownership and roles and responsibilities between the public and private sector.

A significant amount of policy and investment are being driven forward in Wales to manage the current and future risks from flooding. The extent to which these interventions will help to control flood risk to businesses remains unclear, largely due to a lack of evidence on business readiness for flooding, especially within Small and Medium sized Enterprises (SMEs). Keeping flood risk to businesses at today's levels, given the rising risks from climate change, requires additional measures to support and enhance existing plans and actions.

## Benefits of further adaptation action in the next five years

There will be significant benefits from further action in the next five years from low-regret actions to improve the evidence base and provide further awareness raising, advice and support to businesses to improve their resilience to flooding. Quantifying risks and impacts is difficult, particularly for individual business sectors, where data is often commercially sensitive.

However, if further adaptation measures are taken in addition to what is currently planned, then the UK-wide expected annual damages for non-residential properties will decrease by -5% by 2050 and increase by 1% by 2080 compared to present day levels of expected damage, under a +2°C at 2100 scenario. Figures for a +4°C at 2100 scenario are a 5% increase by 2050 and a 21% increase by 2080.

Businesses should also make use of the flood forecasting and warning services to plan for and respond to flooding in their areas. It is likely that improving the uptake of property flood protection by businesses will also have significant benefits in the next five years.

## B2. Coastal business locations and infrastructure

Business and Industry					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	B2. Coastal business locations and infrastructure	Coastal flooding, extreme weather, erosion and sea level rise	More action needed	EERA	ESNR

### Summary of risk definition and description

The CCRA3 Technical Report focused on the risk of coastal change and potential impacts on coastal businesses and infrastructure. This summary should be read in conjunction with the commentary for Risk [I3](#) on impacts on Coastal infrastructure, [H3](#) related to flooding impacts on communities and [H4](#) which considers the viability of coastal communities. To reiterate from these sections:

- Extreme water levels are expected to increase during the 21<sup>st</sup> century and beyond and without further adaptation (e.g. raising flood defences, managed retreat) the projected increases in extreme water levels will significantly increase coastal flood and erosion risk.
- The likelihood of compound effects from tidal flooding and extreme rainfall is increasing, which can greatly exacerbate flood impact. Future sea level rise will increase the coastal flood and erosion risk and increase exposure of businesses in coastal zones.
- Long term planning is in place as SMPs are in place for the full length of the Welsh coastline. These focus on planning for sea level rise and climate change for the next 100 years. In addition to the analysis in [I3](#), [H3](#), and [H4](#), CCRA3 analysis suggests:
  - Businesses facing a change in the coastal management designation from protected to unprotected (e.g. Managed Realignment, or No Active Intervention) are likely to experience significant challenges including loss of value of capital assets located in that coastal area, inability to access financing to relocate out of the blighted coastal area, and potentially complete business failure.
  - Infrastructure providers in the same context potentially face complete loss of coastal access roads and high costs of decommissioning existing coastal infrastructure to remove any potential for harm from degraded assets. Risks may arise from maladaptation where private defences undertaken by business owners exacerbate wider risk.
- Risks and response in relation to port, marine, leisure, heritage, tourism, fisheries and hotel businesses operating in a coastal environment are examined. These businesses face the same risks as outlined in [H4](#). This includes mortality, physical and mental health impacts, damage to property, financial implications of cleaning up or moving, and disruption in terms of access to employment, education, health services and wider facilities.
- As outlined in [B1](#), future flood projections commissioned by CCRA3 have assessed the impact of three different adaptation scenarios on future risk to non residential properties: continued level of adaptation, reduced whole system and enhanced whole system. Figure 15 shows scenarios for a reduced whole system approach focused on coastal flooding, showing levels of risk to Wales in 2050 and 2080. For Wales the current magnitude is already high, with tens of millions of pounds of damage today, and expected to increase further in future in the absence of additional adaptation.

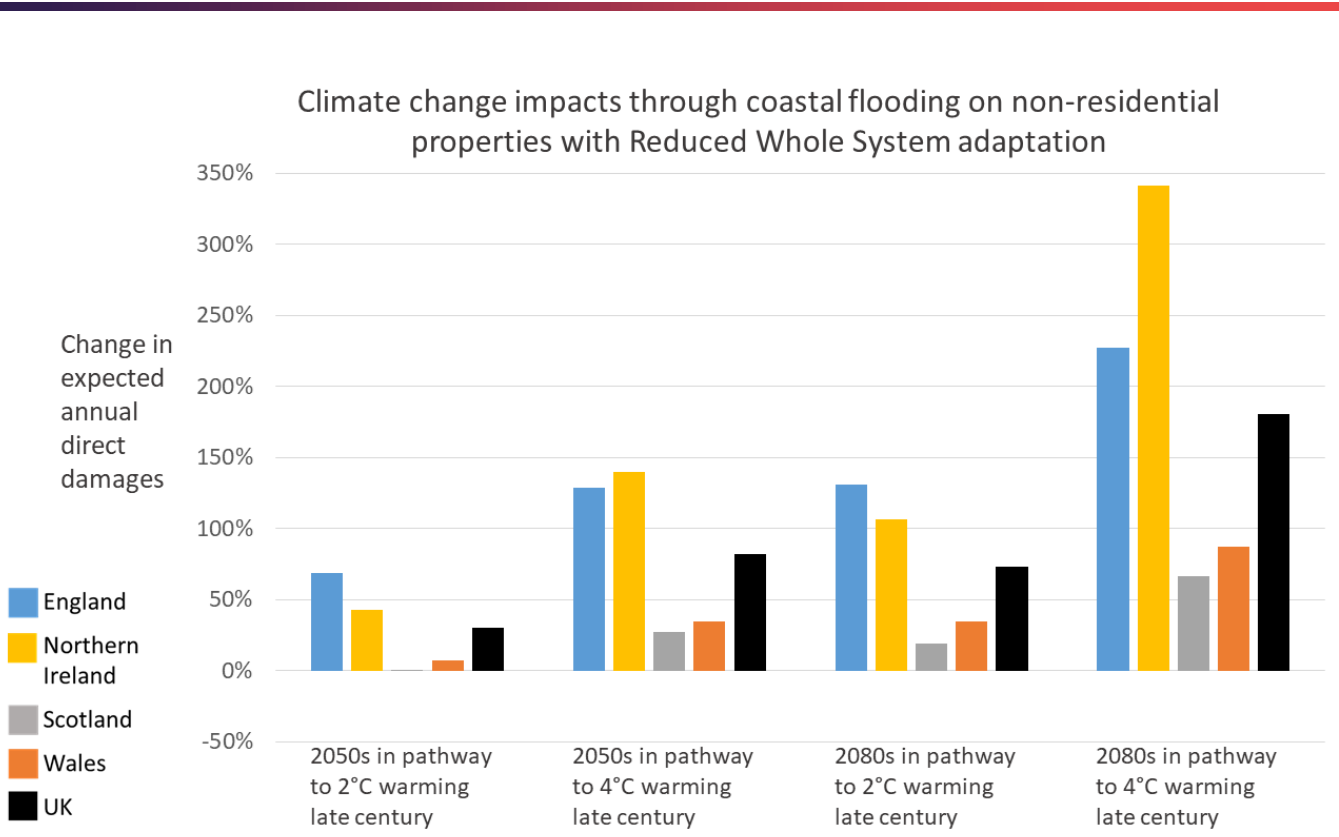


Figure 15: Future risks; percentage change in expected annual damages to non-residential properties for a 2-degree and 4-degree scenario, coastal flooding, direct, £millions (taken from Business and Industry technical chapter).

## Benefits of further adaptation action in the next five years

Financial resources will not be available in the future to defend the entire coast of Wales and so it would be beneficial to prioritise the allocation of resources for coastal protection. Without this prioritisation, all assets could be at risk of damage. In the context of generic coastal risks to businesses, respondents to a London School of Economics (LSE) business survey highlighted adaptation strategies that were occurring, common across both coastal and non-coastal businesses:

- Investing in ‘hard’ engineering solutions, for example upgrades to flood protection, new water saving devices and heat reduction in offices.
- Developing and implementing enhanced business continuity plans that consider current and future risks including regular reviews and tests.
- Investing in ecosystem services and green solutions to reduce risks, for example natural water storage and drainage, green roofs and tree planting.

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In addition to the broad sectoral suggestions made at the beginning of this section, the Technical Report provides the following suggestions of activity which would support adaptive management:

- Transparency about protection levels and protection limits to avoid false sense of security.
- Link future risks into coastal management and development visions of coastal communities to set realistic expectations and increase public engagement.
- Investments in community resilience.
- Research into business opportunities in high risk coastal locations.
- Reduced financial instability.
- Community engagement, for example strategic planning for caravan park businesses and their inhabitants needs to be inclusive. This would ensure adaptation strategies are most suited.

## B3. Business production processes

Business and Industry					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	B3. Business production processes	Water scarcity	Further investigation	EERA	ESNR

### Summary of risk definition and description

The Technical Report explores risks from water scarcity in relation to business production processes for cooling and heating, washing products, dissolving chemicals, suppressing dust and also as a direct input to products. Businesses obtain water either directly through the public water supply system, or through direct abstraction from natural sources such as rivers and groundwater supplies. Large abstractors include industrial processes, manufacturing and mining and quarrying businesses, chemicals and chemical products, basic metals, paper and paper products, beverages, food products and coke and refined petroleum products.

This summary should be read in conjunction with the commentary for Risk [18](#) on reduced water availability for public water supplies and [H10](#) on water quality and public water supply interruptions. As summarised in these sections, the UK faces an increased demand for water in a changing climate. Analysis commissioned for CCRA3 indicates that water resource regions in England and parts of Wales are projected to be in deficit under a central population scenario and a +4°C at 2100 scenario without additional adaptation and that while adaptation efforts in the sector are well advanced, assisted by five yearly Water Resource Management Plans, more action is needed in addition to current adaptation approaches.

Evidence projects that Wales' Supply-Demand Balance in the mid-century could be between 110 MI/d and 60 MI/d depending on the extent of climate change and population growth and assuming no additional adaptation to today. The Supply-Demand Balance for the central population projection is between 60 and 40 MI/d for +2°C and +4°C at 2100 scenarios respectively. In the late-century Wales' Supply-Demand Balance could be between 110 MI/d and -130 MI/d depending on the extent of climate change and population growth and assuming no additional adaptation to today. The Supply-Demand Balance for the central population projection is between 60 MI/d and -10 MI/d for +2°C and +4°C at 2100 scenarios respectively. In addition:

- The challenge across the UK remains the reliable supply to regions where demand is highest, and a deficit is projected. Cross-regional transfers will need to be based on long-term modelling to ensure that regions from which water is being transferred do not experience a deficit.
- There are key interdependencies and cross-cutting risks related to water availability include disruption to power supply, river, surface and groundwater flooding leading to an increase in run-off and debris causing a reduction in water quality, direct water supply disruption from drought, impact on soil condition with subsequent water quality impacts, slope or embankment failures leading to reservoir failures.

In addition to the analysis in [18](#), the CCRA3 explores evidence which suggests that if not well-managed, risk of water shortage is projected to become material in investment and employment for water intense business sectors. The analysis suggests that water intense manufacturing sub-sectors such as chemicals and chemical products, basic metals, paper and paper products, beverages and food products are vulnerable to water scarcity. Further analysis suggests that:

- Changes in product design in one sector drive up water demand in another and this can lead to increased water demand or a shift in the location of demand (for example, packaging from paper to plastic).
- In scenarios where self-sufficiency, sustainability and increased demand for home-grown products is valued, in the absence of other adaptations, there could be increased water demand across a variety of industries.
- Many businesses did not have a contingency plan in place to allow them to continue operation with a reduced private water supply through an extended drought scenario.
- The cost of responding to a drought emergency are higher than those of building long-term resilience to the same event.
- Some businesses have considered where water scarcity will affect wider supply chains and not just site locations including Marks & Spencer.
- There is emerging evidence of businesses investing in ecosystem services such as natural water storage to prepare for drought conditions, new water saving devices, and business continuity plans for water scarcity situations.

Dwr Cymru (Welsh Water) [identify four areas of concern](#) related to climate change in terms of demand and supply: North Eryri/Ynys Mon in north Wales, the SEWCUS area in south Wales covering Cardiff, Newport and the Valleys and Tywyn Aberdyfi in west Wales and Pembrokeshire. Large industrial users of water are in Milford Haven in south west Wales, in steel manufacturing in south east Wales and in Deeside industrial complexes in North Wales.

## Benefits of further adaptation action in the next five years

Evidence has found that there are high benefits (although also high potential costs) of further action to reduce the risk of water scarcity. The costs and benefits do not just fall under the category of businesses but are part of a larger picture of action to reduce demand and increase supply across business, infrastructure, and households, with an aim of protecting and enhancing the natural environment. There are also a complementary set of demand-side measures that can be introduced by businesses, many of which are no-regret and low-regret.

Currently, there is a lack of incentives for water companies to help reduce commercial water use, and reduction efforts have been left to the retail market, unlike in the domestic sector. Further understanding of sectoral usage is required for this.

Some simple steps to adaptation include increased collaboration between wholesale and retailers through Water Resource Management Plans, improving meter reading and quality of water consumption data and increased coordination during unplanned events and incidents.

Further, there needs to be a strong framework for the sustainable management of water, for example, by:

- Targeting efforts to bring non-compliant farmers in England into compliance and that ensuring basic legislation is sufficient to support further achievement of good health, as defined by the [Water Framework Directive](#).
- Reforming abstraction licensing to ensure environmental needs are met as a function of every licence and that abstraction charges encourage efficient use; and
- Continuing investment in the [Catchment Based Approach](#) including by exploring ways to encourage private sector support and funding.

Some of the key business benefits of handling water stewardship effectively include reduced water related business risk, increased drought preparedness, reduced carbon emissions from supply and heating of water, continuity of supply from sourcing locations for retail businesses, cost savings associated with water efficiency, strong engagement with the local community and reputational benefits.

## B4. Business access to finance, investment and insurance

Business and Industry					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	B4. Business access to finance, investment and insurance	Extreme weather	Sustain current action	Economy, Transport and North Wales	ESNR

### Summary of risk definition and description

The CCRA3 Technical Report explores the potential impact of climate change on access to capital for businesses, the affordability of insurance, the reduction in the value of assets and investment and increased credit risks and cost of capital. The analysis suggests:

- Despite a growing number of UK companies engaging in risk disclosure of climate risks, only a very small number do this strategically in underwriting, investment planning, credit or operational aspects.
- Internalising climate risks and pricing it into insurance, lending or investment decisions will have implications for those relying on access to capital and insurance.
- There is limited evidence of physical climate risks being a key driver in price changes, but this could change suddenly in the wake of more extreme events.
- Regulators are suggesting that companies conduct stress-testing for different scenarios including +4oC at 2100 scenarios, which are no longer dismissed as unrealistic.
- Work is underway to develop a framework for a standardised approach to assessing the impacts on different elements of the financial sector.
- The importance of contingent business interruption which planning which calls for more emphasis on business interdependencies.

Key issues which emerge from the CCRA3 analysis include:

- Availability and affordability of insurance. There is evidence emerging of increased insurance costs after the 2019 floods and as a result of heatwave events in the UK. In some high risk areas businesses are reportedly experiencing difficulties accessing insurance cover for flood risk.
- Increased costs of capital. Evidence suggests that future impacts from extreme weather events are expected to increase capital costs due to impairment of fixed assets, inventory write-downs, costs of repair, retrofitting and acquisition of new sites. Capital costs are expected to be most significant in the case of [tail risks](#), as capital in institutions will be insufficient to absorb climate related losses.
- Investment needs for adaptation: Evidence suggests that private sector capital is essential in financing the transition to a climate resilient future and significant financial investments are needed, that the lack of adaptation and resilience metrics is a key constraint for channelling capital into adaptation and resilience investment opportunities.
- The opportunity in Wales for Banc ([Development Bank for Wales](#)) to support climate adaptation through its core activities including loans, equity investment, seed finance, finance for business purchase, property development loans, co-investment alongside banks, crowd funders, grants, investors and other lenders. Banc is a wholly owned subsidiary of the Welsh Government with part of its mission to deliver the Welsh Government's policy objectives which include climate change.



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## Benefits of further adaptation action in the next five years

In addition to the broad sectoral suggestions made at the beginning of this section, the CCRA3 Technical Report provides the following suggestions of activity which would support adaptive management:

- Imposing requirements on banks and insurers. Regulators could prescribe additional capital on a case by case basis, for instance if a financial institution does not adequately monitor and manage climate related risks.
- Broadening scope of existing regulations to encourage more scenario-based analysis among financial institutions on a regular basis.
- Insurability: Risk-sharing agreements between private and public financial institutions, similar to that seen in flood insurance, to meet financing gaps.
- Disclosing and reporting: Further standardisation and clarification on scenario analysis models would help so that comparisons can be made.
- Financial and physical risk metrics: Unless physical risk is being reduced through more adaptation investment and action, damages are likely to occur leading to financial implications.
- Incorporating risk reduction and data into insurance requirements.
- Financing adaptation: Further research would be beneficial in new products, such as resilience bonds, which would use premium discounts for long-term planning, such as investment in sustainable infrastructure.
- More collaboration between different parts of the financial system.
- Digital investments: Predictive modelling and decision-making based on algorithms has potential to change the way businesses view, understand and analyse risks, as well as adopt adaptive behaviours.

### Case Study 7: Wales Pension Partnership

The Wales Pension Partnership (WPP) which pools assets from eight local government pension schemes, announced in July 2020 that it recognises that climate change represents a material financial risk to its stakeholders and its constituent authorities.

The WPP expects its investment manager to ensure that all underlying active managers integrate the consideration of climate-related risks into their investment process and to regularly challenge underlying managers to evidence their approach. They will have to provide monitoring on climate-related risk exposure in their quarterly reports. The pension fund will also continue to apply climate risk focus by engaging with companies it invests in and through voter rights.

There will be an annual report on the climate risk policy, with the eight constituent pensions schemes being responsible for their own investment strategy including climate risk policy.

Source: [Wales Pension Partnership](#)

Image: [Coins \(Unsplash\)](#)



## B5. Reduced employee productivity in businesses

Business and Industry					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	B5. Reduced employee productivity in businesses	Infrastructure disruption and higher temperatures in working environments	Further Investigation	Economy, Transport and North Wales	ESNR

### Summary of risk definition and description

The analysis in the CCRA3 Technical Report explores how a changing climate has the potential to affect productivity both negatively and positively through indirect impacts as a result of infrastructure disruption and higher temperatures in working environments, with subsequent impacts on employee health and wellbeing, ability to commute to work and heat stress. The risks are likely to vary widely across business sectors or geographies, with factors such as the type of work (e.g. construction or industrial processes), whether it takes place indoors or outdoors, and the local built environment and infrastructure factors. CCRA3 analysis suggests:

- There is some evidence available on future risks to labour productivity in the UK related to outdoor labour productivity, urban productivity in the financial sector of city economies for industrial and construction sectors and the scale of benefits (particularly in terms of avoided loss of productivity) of cooling from green and blue space in urban area.
- Research undertaken through the [Co-designing the Assessment of Climate Change Cost](#) (COACCH) project assesses the economic cost of climate change in Europe projected towards the end of the century. It suggested significant direct impacts of temperature extremes on productivity in industrial, construction and tourism sectors, less impact on the services sectors given this is predominantly indoor activity and productivity losses being between -5 and -10% for the agriculture sector in the UK which will likely be transmitted through overall economic activity and have multiplier negative effects.
- Business decisions today about design and operation of office buildings and sites will determine future risk levels and are important given the lifetime of these investments. The performance of these under heat stress and extreme weather are important factors for productivity.

In 2020, the Welsh Government [commissioned a survey](#) of Welsh businesses to identify how best to support them to adapt to higher working temperatures and infrastructure disruption because of climate change. 243 SMEs responded via survey and interview. Key findings are that most business do not currently see climate risk as a pressing issue, they are unclear on the risks, few are acting and they have insufficient information. Businesses currently do not perceive either higher working temperatures or infrastructure disruption (from flooding or otherwise) as risks. Welsh Government plan to take recommendations from the report to develop guidance and support to businesses, focussing on provision of appropriately framed information and work with early adopters from the target group

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## Benefits of further adaptation action in the next five years

In addition to the broad sectoral suggestions made at the beginning of this section, the CCRA3 Technical Report provides the following suggestions of activity which would support adaptive management:

- Robust estimates of the impacts of heat and infrastructure disruption on UK productivity are still needed and there is general need to improve the evidence base through further research.
- Collecting business continuity information on productivity and extreme weather is critical to understanding this risk better.
- Collaboration between businesses, building owners, government and infrastructure operators would help facilitate adaptation, replicating the scale of engagement and collaboration related to Net Zero and flooding.

## B6. Disruption to business supply chains and distribution networks

Business and Industry					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	B6. Disruption to business supply chains and distribution networks	Extreme weather	More action needed	Economy, Transport and North Wales	ESNR

### Summary of risk definition and description

The CCRA3 Technical Report describes how climate change is likely to contribute to an increase in exposure to supply chain disruption by driving an increasing frequency of adverse weather events and evolving climate hazards both in the UK and overseas. Risk levels vary according to location and sector. Factors such as reliance on single transport routes and dependence on particular commodities influence the impact that disruptions can have on businesses. The analysis suggests that extreme weather is already a highly rated cause of disruption for business supply chains including for example outsourcer failure, health and safety incidents and fire. However it is important to differentiate between acute one-off climate disruptions and chronic, longer-term disruptions which can increase supply cost, lower quality, affect delivery of supply and the need for alternatives. Climate change is regarded as different than other shocks for supply chains due to more frequent, severe and longer-duration supply chain disruptions, disruptions in more places, and supply chain disruptions during transitions. The analysis suggests the following:

- Adverse weather has the potential to affect the profitability of entire sectors through impacts on local and global supply chains, particularly agriculture and food which is particularly exposed to weather and climate.
- Future risk will depend on the attributes of future supply chains (e.g. length, complexity, interconnectedness and nature of relationships). The current trend for increasing complexity and interconnectedness brings growing uncertainties and challenges relating to managing risk.
- Supply chain risks can be locked in if UK companies invest in transport routes, distribution hubs or production centres that are more exposed or vulnerable to climate hazards.
- Supply chains create a network of interdependencies, through which UK businesses can be exposed to all of the risks faced by their suppliers, producers, transport routes and customers with significant potential for their own interaction between a wide range of risks.
- Adaptation can involve bridging, which involves the buyer taking action to help build up the capacity of its suppliers to manage during and recover from disruptions or buffering, which involves the buyer taking action to protect itself from the consequences of supplier failures. Bridging strategies include collaborative planning and control, financial support and strengthening relationships with suppliers. Buffering strategies include inventory, capacity, liability, lead time and cost buffers.
- Research from Wales on Welsh Government Capability, Suitability and Climate Programme [Report](#) on crops and the [ADAS Review of Land Use Climate Change](#) are used as examples of how collaborative work can provide insight into supply chain disruption.

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## Benefits of further adaptation action in the next five years

The CCRA3 Technical Report suggests that there is a role for both the public and private sector in driving resilience through supporting and incentivising their own supply chains and implementing adaptation measures through scenario analysis, risk assessment, approaches to insurance, risk disclosures, contractual arrangements that take adaptation into account, business continuity measures and evidence gathering. It also suggests that there is also a role for government in capacity building and setting the right institutional environment for suppliers to address climate risk.

## B7. Changes in demand for goods and services

Business and Industry					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
OPPORTUNITY	B7. Changes in demand for goods and services	Long term climate change	Further investigation	Economy, Transport and North Wales	ESNR

### Summary of risk definition and description

Previous CCRA3s have described how climate change could potentially affect production costs, comparative advantage, and demand for certain goods and services. CCRA2 found that with sufficient information and climate change expertise, businesses could be expected to respond to market signals and exploit opportunities as they arise. The CCRA3 Technical Report focuses on opportunities for businesses, examining barriers to adaptation and suggesting a role for government intervention to help companies realise these opportunities, similar to measures that have supported businesses to commence carbon management. The analysis examines the following evidence:

- The Climate Change Committee (2019) [reported on progress](#) in planning for business opportunities presented by climate change for England. Opportunities for growth in the goods and services sector including engineering and manufacturing products, cooling services in transport, construction and real estate, retail and manufacturing, tourism, insurance and other finance products as well as agriculture horticulture and food products, consultancy and adaptation advice.
- Other research focuses on opportunities for transit shipping through the Arctic, for wild capture fisheries, maintenance in the heritage sector and the construction industry (opportunities for agriculture, forestry and marine sectors are also outlined in [Section 4](#)).
- The analysis identifies that more evidence is needed to understand the potential in the UK for urban green infrastructure provision and maintenance, rural land use industries, afforestation, peatland restoration, on-farm reservoir creation and maintenance, agricultural diversification, enhancement of the night time economy in urban areas, the extension of the local tourist season due to warmer summers and the implementation of management standards for climate adaptation.
- Given low levels of understanding of the opportunities to businesses from climate change, and the likely barriers to small businesses in particular to enter new markets, there is likely to be a role for Government in providing evidence and supporting businesses to transition to new functions as the climate changes as part of economic, agricultural, forestry and regeneration planning.

### Benefits of further adaptation action in the next five years

In addition to the broad sectoral suggestions made at the beginning of this section, the CCRA3 Technical Report provides the following suggestions of activity which would support adaptive management:

- Further investigation into emerging sectors and gathering case study evidence particularly for the retail sector.
- Aligning climate adaptation investments alongside low carbon retrofitting of building stock and the regulatory and institutional networks required to facilitate these opportunities.
- Reassessment of opportunities in some sectors in view of lock-ins, maladaptation, threshold effects and associated transition risks (e.g. of cooling products related to Net Zero targets).
- Inclusion of climate adaptation opportunities in 'green stimulus' and recovery packages post COVID-19.

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## 8. International dimensions



*Image: © Pembrokeshire Coastal Forum. The Port of Milford Haven including Pembroke Dock Ferry Terminal in Pembrokeshire is a leading UK gateway handling liquid, bulk, break bulk and heavy lift cargoes. It handles over 30 million tonnes of cargo annually. It is known as the UK's largest energy port and is capable of delivering 30% of the UK gas demand.*

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The CCRA3 Technical Report examines the evidence of climate change impacts organised across ten key international dimension risks covering: food production, violent conflict, human mobility, health and governance. Analysis also includes an overarching risk on international risk cascades when risk multiplication results from interactions between risks across systems and geographies. This section provides:

- A summary and description of each risk associated with international dimensions.
- Suggestions from CCRA3 on the benefits of further adaptation over the next five years.

It states that while ultimate control of flow of goods, finance, people and information which influence international risks is typically reserved to the UK government (e.g. trade agreements, tariffs and border controls), separate governance arrangements exist in Wales and other devolved administrations which determine how the international risks play out in different places. Both direct and cascading effects of these international risks can be considered for Welsh business and industry, infrastructure, natural environment and for the health, people and communities of Wales. Welsh Government and local authorities will also be able to consider how they can use both devolved powers and local strategy to build resilience to these risks within Wales. The analysis has found:

- Risks associated with the international dimensions of climate change are greater than previously thought related to observed climate impacts, changes in geopolitics, and greater evidence for climate change acting as an amplifier of risk.
- A new and clear case for more action to manage the risk of international conflict through increased international coordination and active promotion of long-term stability (for example, with respect to natural disasters and food supply chains).
- Climate related international human displacements require further action, through building long term resilience in exposed regions, avoiding the need to divert funds to provide humanitarian aid and ensuring climate migration has positive outcomes.
- Risks to international law and governance are newly identified areas where more action is needed such as renewed engagement with multilateral processes and institutions to close adaptation gaps for this risk.
- Health risks to the UK from international risk cascades also require more action through improved awareness monitoring and surveillance and activities to address mental health issues emerging from climate change.



- Adaptation planning is required for weather related shocks to international food production and trade and from climate induced risks to UK food availability, safety, and quality. There are also opportunities identified drivers in international food systems such as plant-based meat substitutes.
- Analysis of international risk cascades suggests that the international dimensions of climate change are greater than the sum of the component risks identified in this chapter. These risks also increase with time, because the multiplicity of low likelihood risks and interactions have a longer period in which to arise. COVID 19 is used as an example of a risk cascade that creates systemic risks to the economy and healthcare, people movements and supply chain disruptions - leading to an ongoing shock of enormous magnitude.

The CCRA3 Technical Report uses a framework that includes the most common transmission pathways through which risks occurring outside the UK may cascade into the UK, shown in figure 16 below:

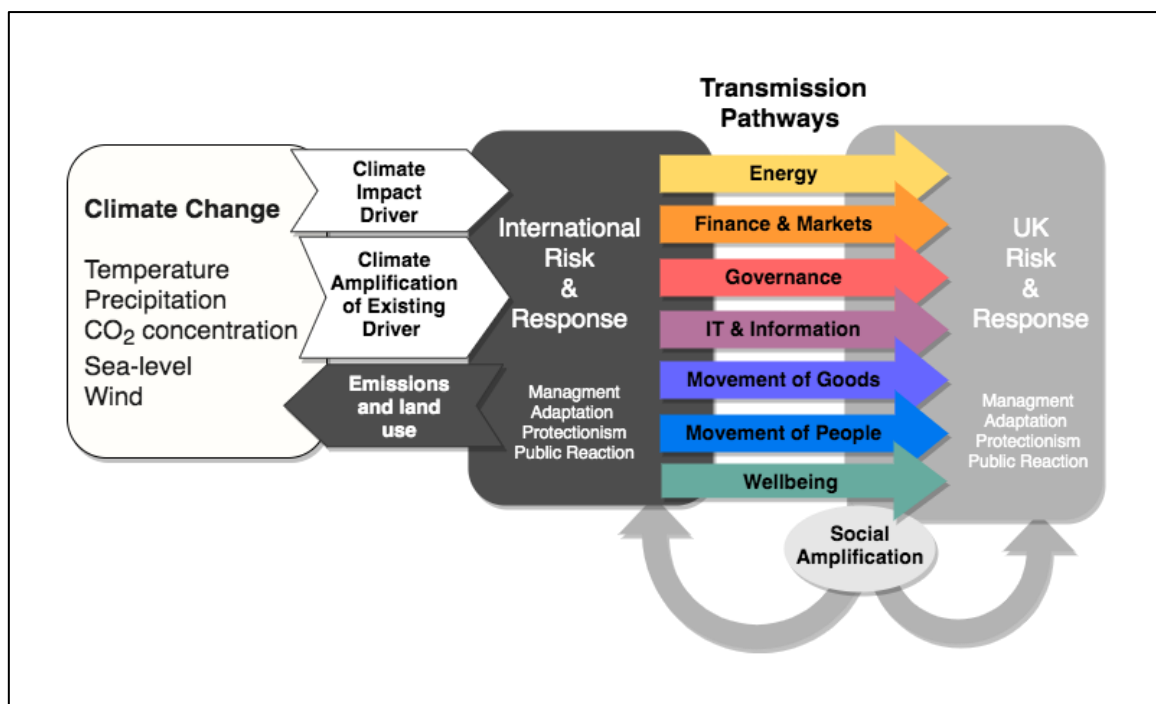


Figure 16. Diagram of pathways of transmission of international climate risks and impacts to the UK.



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Most of the risks and opportunities arising from international climate change have remained the same, but in some cases their urgency has increased as shown in the table below.

<b>Risk, Opportunity or Risk and Opportunity</b>	<b>Urgency Score CCRA2</b>	<b>Urgency Score CCRA3</b>
ID1. Risks to UK food availability, safety, and quality from climate change overseas	<b>Research priority</b>	<b>More action needed</b>
ID4. Risks to the UK from international violent conflict resulting from climate change overseas	<b>Research priority</b>	<b>More action needed</b>
ID5. Risks to international law and governance from climate change that will impact the UK	<b>Research priority</b>	<b>More action needed</b>

There follows a summary of all climate risks and opportunities related to the implications of climate change from the rest of the world.

## ID1. UK food availability, safety, and quality

International Dimensions					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	ID1. UK food availability, safety, and quality	Decreasing yields from rising temperatures, water scarcity and ocean changes globally	More action needed	EERA	ESNR

### Summary of risk definition and description

The CCRA3 Technical Report explores how climate change is likely to exacerbate disruptive events that impact on agricultural production and food supply chains (droughts, agricultural pests and diseases, storms), with increased risks of disruptions associated with multiple production areas including on crops; livestock, aquaculture; wild and wild caught fisheries. The analysis focuses on the following:

- That all components of risk related to the food system (hazards, exposure and vulnerability) seem to be increasing given the increased likelihood of extreme events from climate change and with risk cascades amplifying the effects.
- The major risk to food security from climate change in the UK is the variability in access associated with supply side disruptions arising from variability in the weather, and the potential for cascading and interacting risks.
- Evidence and research related to impacts on markets, climate induced food shortages, agricultural shocks, climate tipping points, food safety and EU Exit indicate that more action is needed.
- A case study on fresh food shortages in 2017 in the UK illustrates the relationship between growing conditions in Spain, southern France and north Africa combining with poor growing conditions in the UK and resulting in difficulties in supplying fresh produce to the UK ([case study 8](#)).
- The fragility of supply chains with just in time systems lock-in vulnerability of UK food systems to climate change, implying a requirement to develop food systems that are resilient to disruption.
- While food trade is a reserved issue, local food security depends on intra-UK food supplies (part of which is imported). Local governance of food is also devolved. This means there is potential for an external food trade 'shock' to resolve differently across the devolved administrations related to food prices and availability.
- Growing academic evidence that there is a fundamental lack of systemic resilience. This was brought into sharp focus by planning for the potential shock of EU Exit, and particularly the recognition it brought about fragile supply chains for food and medicine, and by the actual shock to the global system arising from the COVID-19 pandemic.

### Benefits of further adaptation action in the next five years

The CCRA3 Technical Report recommends the following to facilitate adaptive management:

- Greater focus by Government on adaptive management, research and learning on resilient food systems.
- Consideration of exposure to climate risks in Free Trade Agreements, post EU-Exit.
- Removing barriers to enable and encourage private sector adaptation related to supply chains.
- Developing a multinational regulatory structure in food commodity markets which are most vulnerable to climate-related supply-side shocks.
- Further development and uptake of insurance instruments that protect both domestic and international actors in food supply chains would also contribute to adaptation.
- Ensuring climate risk is factored into policy and programmes for food access inequality.

## Case Study 8: Fresh produce shortages in 2017

An area of concern is the extent to which the UK relies on fruit and vegetable imports as over 80% of fruit and about 50% of vegetables consumed are imported. The [vegetable shortages of early 2017](#) were the result of climatic shocks to the food system.

Poor growing conditions in key sourcing regions, such as Murcia in southern Spain, resulted in rationing and price increases of up to 25-300% across the UK. Shortages were mostly encountered in lettuce, but also courgette, aubergines, tomatoes, peppers, broccoli, cauliflower, onions, carrots and celery. Multiple drivers of shortages were identified, including

[flooding in south-east Spain](#) and [cold temperatures in Italy](#). In Spain, the highest rainfall in 30 years reduced the area of arable land to only 30% of the area planted. Italy shifted from exporting over the European winter to importing. Traders imported from the US to fill the shortfall, thus increasing cost, emissions and contaminants associated with the produce.



During the vegetable shortages of 2017, some caterers and restaurants were bulk buying from supermarkets instead of wholesale, in response to the shortages and price spikes. Some supermarkets appeared to opt for empty shelves rather than paying the higher price. Shortages appeared to be supermarket dependent, with, for example, the Co-op not reporting shortages. This suggests that vulnerability may be the result of a high proportion of imports coming from one region. It also suggests that supply chain management might reduce the future impact of events of this kind. Indeed, some companies have since diversified their growers' networks. For example, Florette have mitigated future risk due to production shortage in southern Spain by moving the grower network of some supply to northern Spain, southern France and northern Africa. Nonetheless, events of this sort continue to occur and interact with UK growing conditions to produce shortages, [as in the case of cauliflowers in August 2019](#).

The socioeconomic and demographic inequalities across the UK result in different exposures and vulnerabilities to the risk of food price spikes. More broadly, environmental hazards exist everywhere and can be related to income, education, employment, age, sex, race/ethnicity and specific locations or settings. In addition to these differences in exposure, inequalities are also caused by social or demographic differences in vulnerability/susceptibility towards certain risks. For example, supermarket shoppers in cities may be exposed to variations in food prices or supply, and they will be differentially vulnerable to price rises, according to their income. Shoppers in rural locations, with access to smaller and more highly dispersed retail outlets, will be exposed to different risks as availability of food will vary more, as well as its price.

Source: [CCRA3 Technical Report International Dimensions Technical Chapter](#)  
Image: Tomatoes (Pixabay)

## ID2. UK food availability and exports

International Dimensions					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
OPPORTUNITY	ID2. UK food availability and exports	Increases in productivity and areas suitable for agriculture overseas	Watching brief	EERA	ESNR

### Summary of risk definition and description

The CCRA3 Technical Report describes climate change as one of a number of drivers which impact on food production patterns through changes in productivity (e.g. higher yields) and/or changes in the land suitable for producing food, extreme events reducing yields, more gradual changes in opening up new areas for production. Available evidence is reviewed on wheat grain and protein yield, fruit and vegetable productivity, winter mortality of pests, livestock production, cropping intensities, pasture and forage productivity and demand for plant-based meat substitutes. The analysis suggests:

- The lack of evidence of global yield increases and the difficulties in the use of marginal land and in water management suggest that food production opportunities will not be the norm.
- Whether or not any import or export opportunities are realised depends upon whether and how food production is translated into increases in food availability. On balance, increased productivity is not the most common projected response of crops to climate change and there are thresholds above which food production decreases.
- Any increases in productivity do not automatically translate into increases in food availability, which is the result of multiple climatic and non-climatic drivers including the balance of supply and demand that determines where food is grown, the extent to which adaptation keeps up with climate change and the course of international trade, as determined by business and by international politics.
- If longer term climate change results in a comparative advantage for UK agriculture relative to other food producing regions, then there may be opportunities for increased exports. Where climate affects overseas production adversely, the UK may be able to make up shortfalls.
- However, there is stronger evidence for a converse effect as anomalously high yields overseas can provide an opportunity for cheaper food in the UK, via global market mechanisms.
- While evidence suggests that Europe and North America might benefit from lower food prices under cropland expansion, developing tropical regions may suffer from decreased biodiversity resulting from the expansion.

### Benefits of further adaptation action in the next five years

Ensuring access to a broad range of international markets would capitalise on any opportunities associated with climate impacts overseas. There is no evidence to suggest further actions that would support such opportunities are currently taking place. Access to markets has the co-benefit of providing some resilience to external shocks, be they climate induced or sourced elsewhere (e.g. a global health disruption such as COVID-19).

## ID3. Migration to the UK and effects on the UK's interests overseas

International Dimensions					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	ID3. Migration to the UK and effects on the UK's interests overseas	Climate-related international human mobility	Watching Brief	Not devolved	Not devolved

### Summary of risk definition and description

The analysis in the CCRA3 Technical Report focuses on climate risk and human mobility. One potential adaptation is displacement and migration with affected areas most likely to be in the global south, exposed to frequent climate extremes with high dependence on agriculture and weak social support programmes. The analysis suggests that since CCRA2 we now have a better understanding of the complexity and diversity of migration as a response to climate change and the role of policy in ensuring that migration produces positive development outcomes in both sending and receiving areas. The assessment focuses on:

- How unplanned, unsupported and precarious climate migration presents risks to the human rights of the people on the move, as well as their wider social and economic opportunities.
- In the longer term, climate change will alter the relative habitability and attractiveness of different places and thus change size and direction of flows of migrants.
- Increased mobility as a result of climate change is likely. Successful adaptation involves ensuring pathways for regular migration minimise negative perceptions and maximise opportunities.
- Most climate related migration in the near future will be domestic, within affected countries or regions. CCRA3 suggests that the UK is unlikely to receive many migrants.
- There is more evidence of what constitutes successful climate change migration which means an increase of the wellbeing of those involved.
- Climate migrants will come to the UK, not as a separate, easily defined group, but as normal economic migrants or asylum seekers.

Key future factors in the UK's approach to this risk will include changes in international relations between the UK and other countries as it exits the EU and changes to UK Government departments dealing with international relations, currently the Foreign, Commonwealth and Development Office (FCDO). The analysis suggests there are limits to the ability of the UK's overseas aid budget to reduce the exposure of vulnerable populations to climate hazards such that migration is not required.

The Report recognises the differences between devolved administration's approaches to migrants and asylum seekers, integration, housing, employment and health and that successful integration will be resolved by through devolved and local policy and planning.

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## Benefits of further adaptation action in the next five years

The CCRA3 Technical Report recommends the following broad approaches which facilitate adaptive management as plans, policies and funding are developed by FCDO and other government departments post EU Exit:

- Supporting climate resilient development, adaptation and appropriate disaster management and preparedness practices will go some way to preventing overseas development gains being undermined by worsening climate change impacts.
- The potential of overseas development activity and funding to reduce vulnerability and increase adaptive capacity to climate impacts and distress migration.

## ID4. The UK's international interests and responsibilities

International Dimensions					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	ID4. The UK's international interests and responsibilities	International violent conflict resulting from climate change overseas	More action needed	Not devolved	Not devolved

### Summary of risk definition and description

The CCRA3 Technical Report focuses on the role of climate as an amplifier of conflict and causal association with other drivers which include, but are not limited to, pre-existing conflict (at local and national scales), level of democratisation, post-colonial transformation, economic context, and population growth. The analysis suggests that overseas conflict can have an indirect impact on the UK through a variety of UK overseas interests, and various transmission pathways such as governance, finance and markets. The following factors are key determinants of this risk:

- For UK interests, state failure and poor governance could increase demand for military intervention to protect UK interests or allow other countries or non-state actors to reduce UK influence in affected areas. The breakdown of state structures could lead to greater insecurity for trade and transport related to supply chain risks.
- There is strong evidence that many factors that increase the risk of civil war and other armed conflicts, such as poverty levels and income shocks, are sensitive to climate change.
- There is a higher likelihood of conflict in 'medium-democratised' governments compared to 'full-democratised' governments. Temporary or permanent displacement of people within countries could also increase the likelihood of conflict within countries through bad policy or planning.
- Evidence is growing of the causal association between climate and conflict. Examples are used from Lake Chad, Syria and the Arab Spring, linked to ecological change, water, drought and food shocks and problems with food access and availability respectively. There is also evidence of temperature extremes and long climate events associated with conflict outbreaks in Africa.
- The analysis also acknowledges the risks associated with flooding events fuelling existing conflict, the potential for urban and agricultural sector conflict over water resources and the potential of food price shocks leading to riots and unrest.
- In addition, regions in conflict and post conflict have low adaptive capacity and may themselves be highly vulnerable to future impacts of climate change.

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## Benefits of further adaptation action in the next five years

The CCRA3 Technical Report states that the case for adaptation is now clearer than it was in CCRA2 and therefore more action is now justified, with the following broad observations:

- The benefits of reducing current tensions through appropriately deployed international agreements on shared resources including access to water (where rivers run between countries) or new opportunities in areas such as the Arctic.
- While the Ministry of Defence includes climate change within its strategic threat considerations, there is no evidence of a systematic review of impacts of all UK investments and partnerships across government in tackling geopolitical issues.



## ID5. Changes to international law and governance affecting the UK

International Dimensions					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	ID5. Changes to international law and governance affecting the UK	Reduced international collective governance due to climate change and responses to it	More action needed	Not devolved	Not devolved

### Summary of risk definition and description

Analysis in the CCRA3 Technical Report describes risks to international law and governance from climate change, which include human rights violations, contestation of well-established international rules, risks of sovereign defaults in emerging economies and new legal challenges arising from low carbon policies. Such risks have the potential to threaten the UK's economic, diplomatic and military interests and challenge its foreign policy of strengthening the rule-based international system and promoting human rights. Key observations on this risk are:

- International law may be weakened by the climate crisis as it struggles to respond to a challenge that questions some of its foundational concepts such as that of statehood or territory. Although it provides a framework to mitigate climate risks that offers positive prospects, it is highly dependent on states being willing to design ambitious climate plans and cooperate internationally.
- Climate risks to international law and governance are amplified politically by a weakened multilateral system and states acting in their self-interest in a context of resource scarcity as well as socially by popular discontent towards globalisation.
- The impacts of climate risks on international law have had limited consequences for the UK so far. However, in the long term they are likely to grow if political and social contestation grows and if states are unable to cooperate to develop adequate international legal frameworks.
- Climate risks might manifest themselves in the following ways in relation to international law and governance:
  - Ethnic tensions and violations of human rights laws through climate migration in states with inward-looking nationalism and populism.
  - Threat to democracy and civil and political rights as states respond to climate change by augmenting their powers and circumscribing rights.
  - Contestation or reinterpretation of well-established international treaties that are, in their current form, inadequate to respond to climate impacts. For instance, sea level rise and maritime boundaries delimitation, transboundary water resources, international watercourses, fish stocks and mineral resources.
  - These may include direct risks to the UK's military, diplomatic and trade interests as a major maritime power and British Overseas Territories by aggravating tensions in territories that are disputed or by increasing pressure on their resources.
  - Systemic risk to national economies via shocks of climate related events and risks from public spending for reconstruction, increasing the risk of sovereign defaults in emerging economies.
  - State led enterprise, resource protectionism and strategic bilateral agreements that secure long term access to resources at the expense of the global markets which UK businesses rely on.

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## Benefits of further adaptation action in the next five years

The CCRA3 Technical Report also provides the following broad observations:

- Diplomacy is the main means of adaptation in relation to this risk with engagement with multilateral processes and institutions through its work with United Nations, Commonwealth, EU and International Law Commission.
- The UK's diplomatic action outside of the climate realm could have significant impacts as to its ability to attenuate risks to international law and governance from climate change.

## ID6. Increased trade for the UK

International Dimensions					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
OPPORTUNITY	ID6. Increased trade for the UK	Arctic ice melt opening up new trading routes	Watching brief	Not devolved	Not devolved

### Summary of risk definition and description

The Technical Report explores the trade opportunities that may arise as a result of melting sea ice the opening of Arctic trade routes. The present analysis confirms that the UK has some capacity to benefit from increased access to the Arctic, as a consequence of climate change, in relation to maritime services and tourism. CCRA3 provides a broad commentary on this opportunity suggesting that potential benefits will increase over time from increased access to the Arctic and provision of maritime services. However, there are associated risks, some military in nature (see [ID4](#) and [ID7](#)). The analysis suggests that:

- The principal driver is the massive development of Liquefied Natural Gas (LNG) projects in the Russian Arctic, sponsored by the Russian Government, originally in terms of the delivery of construction materials and supplies, and latterly through the export of Arctic LNG to Europe.
- Northern Sea Route (NSR) traffic has continued to grow since 2016 and is increasingly year round. China's state-owned China Ocean Shipping Company (COSCO) is leading interest in transit shipping including a 'Polar Silk Road' through developing Arctic shipping routes.
- The International Maritime Organisation (IMO) [Polar Code](#) (2017) has mandatory requirements relating to the operations, regulations, construction and equipment and the protection of the environment and ecosystems. The UK maritime sector (including the maritime service sector in the City of London) is well placed to be a global leader on how to implement the Polar Code into new build design for ice-capable ships to ply emerging Arctic trade routes.
- Growing commercial interest in Arctic trade routes also brings with it growing interest in military opportunities and risks. The Ministry of Defence announced that it would put 'the Arctic and High North central to the security of the United Kingdom' through the development of a new defence strategy for the region, yet to be published. CCRA3 suggests that the military requirement to improve situational awareness in the region will increase demand for innovation and ultimately cheaper technological solutions, which could create commercial opportunities for the UK.
- There is some evidence which indicates that opportunities from climate change (including Arctic ice melt) on international trade routes include a reduction in transport distance between suppliers and consumers, potential tourism opportunities through increased access to the Arctic, and associated port development in locations that facilitate these trade and tourism opportunities.
- The uncertain pace of sea routes opening, both in any given year but more generally over longer time periods, may result in sunken assets through the premature investment of ships designed for Arctic voyages, as well as premature investment in port development to serve Arctic shipping.
- In Wales, [Dragon LNG's](#) import terminal at Waterston, Milford Haven in Pembrokeshire receives, stores and re-gasifies LNG. One of just three such terminals in the UK, this forms a critical part of the UK's energy infrastructure, providing a link between the UK and its overseas gas suppliers.

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## Benefits of further adaptation action in the next five years

Key issues identified by the Technical Report to be considered include:

- The economic effects of trade that is facilitated by a reduction in transport distance between suppliers and consumers.
- The effect on UK GDP was estimated to be equivalent to an annual increase of 0.24%.
- Potential tourism opportunities that increased access to the Arctic allows, and associated port development in locations that facilitate these trade and tourism opportunities.

## ID7. International trade routes

International Dimensions					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	ID7. International trade routes	Climate hazards affecting supply chains	More action needed	Not devolved	Not devolved

### Summary of risk definition and description

Analysis in the CCRA3 Technical Report focuses on climate related disruption to non-food supply chains which can impact on production (extractive industries, manufacturing), on transport and logistics, on labour supply, on retail and its logistics and on demand. With globalised supply chains characterised by ‘just-in-time’ delivery they can be fragile and lack resilience to disruptions. There are significant inter-dependencies in the way that trade may respond to climate hazards and the context (geopolitical, policy, market, social) within which the hazard occurs. Given the projected and observed increase in disruptive events, this risk will increase in the future. Current understanding of “ripple effects” is not strong, as impact cost models tend to underestimate costs of climate extremes. Specific features of the risk include:

- A feature of modern economies is the reliance on long, complex, multinational supply chains which are lean with few local stocks being held and the expectation of just-in-time deliveries of goods. This increasingly leads to a systematic fragility and therefore systematic risk.
- Impacts on inland logistics including extreme heat buckling railway tracks for key routes, drought affecting river levels, storm damage to key ports and transport routes. COVID-19 gives insight into the resilience of supply chains following major disruption arising from lack of labour for transport, lack of airfreight or border closures.
- Co-incident hazards are more likely to amplify disruptions to trade networks or climate hazards occurring when the trading system is under other pressures such as those from conflicts or trade wars. The analysis includes discussion of the Fukushima disaster, Thailand Floods and cascading risks on supply chains.
- International supply chains routed by sea trade routes are funnelled through a small number of globally important ‘chokepoints’ whose interdiction could have crucial impact on global supply. These include many routes that are associated with areas of broad geopolitically instability or where there are direct climate risks to the area and its infrastructure.
- Recognition of these potential supply chain risks has risen in the last couple of years with planning for supply chain disruption due to EU Exit and the COVID-19 pandemic. Whilst recognition of disruption to supply chains is becoming greater, each disruptive event has in the past been treated as exceptional. There remains some under recognition that such events are likely to become more prevalent.
- Specific risks associated with new trade routes following Arctic melting are explored, discussing geopolitical risk that may be exacerbated in the future involving building or upgrading of Russia’s network of military bases, US Freedom of Navigation Operations through Russian and Canadian Arctic waters, increased military exercise activity and potential impacts on sea lines of communication in the north Atlantic.

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## Benefits of further adaptation action in the next five years

Given that shocks are likely to increase in future, as climate hazards from extreme events increase, there is benefit from a focus on building further resilience. However, resilience would typically arise from four main properties: building in redundancy (e.g. stocks), diversity (of sourcing, or substitutability), creating modularity or distributed rather than centralised networks, and creating greater flexibility/adaptability. All of these properties have typically been removed to increase efficiency and the leanness of supply chains. Thus, there is a trade-off between fragility (and lower prices) and resilience (and higher prices). As risks increase, the trade-off tips towards resilience providing better returns on average. Resilience as a 'design feature' may become a greater focus for investment during post COVID-19 recovery.

## ID8. Risk to the UK Finance Sector from climate change overseas

International Dimensions					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	ID8. Risk to the UK Finance Sector from climate change overseas	Climate driven resource governance pressures and financial exposure	Sustain current action	Not devolved	Not devolved

### Summary of risk definition and description

An important pathway of transmission of international climate risks and impacts to the UK is through finance. The CCRA3 Technical Report suggests that financial exposure to extreme weather impacts in other countries through insurance markets, banks and investments may be significant. Investment risks are clear where domestic owned assets are exposed to extreme weather events in other regions there may be significant impact on all types of asset classes and potentially put further stress on UK pension funds. The analysis suggests, from the evidence available, that the following factors are important:

- Over the long-term global exposure of the UK finance sector is deemed to be significant as it is highly networked and exposed to risk overseas for example through coastal flooding scenarios.
- UK insurance companies may have significant exposure to climate change impacts overseas through physical, liability or transition risks.
- Whilst banking and insurance sectors have effectively responded to current extreme weather events, the increase in magnitude and frequency means likelihood of 'unhedgeable risk' is higher, straining the insurance sector.
- Large scale negative impacts (including bankruptcy) within an individual organisation due to mismanaged risk exposure can cascade through the system quite rapidly.
- There are still significant systematic risks, given that financial risks are still not integrated within firm operating models or in financial markets as a whole.

In terms of opportunities, the CCRA3 Technical Report indicates that:

- If this risk is managed through adaptation programmes there is the potential for an increase in the need for insurance and therefore an opportunity for the UK insurance market to grow. Expertise, especially within re-insurance companies and catastrophe risk modelling organisations, also offers growth potential for the UK.
- There may be significant opportunities internationally for adaptation investment for UK based firms. For example, UNEP estimates future adaptation needs in developing countries could range from US\$140 billion to US\$300 billion by 2030 and from US\$280 billion to US\$500 billion by 2050.
- There has been an increase in regulatory activity to encourage physical risk analysis and disclosure across the financial sector from UK Government, which is encouraging firms to internalise climate risks, including physical risks. Banks and insurers in the UK are now required to allocate responsibility for identifying and managing climate-related risks to senior management functions.
- Recent developments in responsible investment management such as Environmental, Social, Governance (ESG) metrics are also supporting support climate friendly business models.

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## Benefits of further adaptation action in the next five years

The analysis outlines the following activity which would support adaptive management:

- Developing a better understanding of how disclosing climate related financial information is changing corporate strategies on adaptation, and how investors are using the disclosed information to inform their decisions.
- Renewed efforts on climate finance directed at helping countries protect their vulnerable populations.



## ID9. Risks to public health from overseas

International Dimensions					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	ID9. Risks to public health from overseas	Increase in vector borne diseases due to climate change	More action needed	Health and Social Services	HSSG

### Summary of risk definition and description

The CCRA3 Technical Report considers the introduction of infectious disease from outside the UK from vector borne disease (VBD) and potential risks from climate change and climate variability. Vectors include mosquitoes, midges and ticks and, in rarer cases, birds. VBD disease can currently arrive in the UK through international travel and there is an increasing risk of local transmission of these diseases by vectors in the future. CCRA3 provides analysis regarding:

The potential risks in the UK of West Nile virus (WNV) and viruses that can be transmitted by mosquitos and other insects including dengue and chikungunya and zika virus, tick-borne encephalitis, African swine fever, blue tongue in ruminants and malaria (case study 9).

### Case Study 9: Risks to the UK from competent vectors

The spread of [dengue](#) from nine countries a few decades ago, to being endemic for almost half the world's population today, is highly relevant to ongoing climate-induced risks as people continue to travel and return from these countries. The changes in the distribution of dengue are possibly in part driven by climate change, urbanisation and the ability of mosquitoes to thrive within polluted waters of rapidly expanding urban areas, mostly in the tropics and sub-tropics.



The locally acquired cases of dengue in Spain and France due to [Aedes albopictus](#) reported in September 2019, Italy's first dengue outbreak in August 2020 and the 2017 local outbreak of [chikungunya virus](#) in Italy have shown how vulnerable mainland Europe, frequently visited by UK travellers, is to the introduction of what were seen previously as tropical diseases.

Further areas of concern include the spread of other diseases in the UK. For example, [Culex modestus](#), a competent vector of [West Nile virus](#), has recently found to be well established in the marshland sites of the Thames Estuary and could spread to a wider area. The discovery of the virus that causes [tick-borne](#)

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[encephalitis](#) was found in two places the UK for the first time in 2019. There has also been a more regular introduction and detection of *Aedes albopictus* in Kent.

Source: [CCRA3 Technical Report International Dimensions Technical Chapter](#)

Image: *Mosquito (Pixabay)*

The assessment suggests:

- COVID-19 and the SARS2-CoV-2 virus provides insight into how pandemics of an infectious disease can challenge society.
- Relatively small upward shifts in temperature along with a future run of warmer summers extending into warmer autumns may allow mosquitos to spread in the UK, particularly in urban areas.
- There is a potential link with SuDS in urban and peri-urban areas with high population densities and recreational usage.
- Surveillance of vector species is severely constrained by a lack of resources including tick recording schemes and surveillance of endemic and invasive mosquitoes.
- It will be important to maintain access to EU international public health surveillance systems and that surveillance at borders will be of increasing importance.

## Benefits of further adaptation action in the next five years

The following activity would promote adaptation to emerging diseases:

- More real-time monitoring of air travel routes, transmission pathways of movement of people and goods.
- Communication of outdoor risks if a vector-borne disease is introduced.
- Training and awareness of primary health care practitioners.
- Raised levels of surveillance and some random screening (for example, part of blood donation screening for antibodies). COVID-19 has provided a good example of the scale of impact costs and how this can cascade into other sectors. Therefore, it shows that investments in surveillance can pay off to avoid high impact situations.
- Improvement of public and professional level information, transmission pathway IT/information.

## ID10. Risk multiplication to the UK

International Dimensions					
Risk or Opportunity	Receptor	Nature of risk/opportunity	Urgency Score	Welsh Government Risk Owner	
				Ministerial Portfolio	WG Department
RISK	ID10. Risk multiplication to the UK	Interactions and cascades of named risks across systems and geographies	More action needed	Not devolved	Not devolved

### Summary of risk definition and description

The analysis in the International Dimensions Chapter describes how a range of international climate risks can interact across multiple sectors, geographies and systems to impact in the UK. It describes how multiple risks related to food, international violent conflict, human movement, trade, markets and finance, health and governance can impact on the UK through various pathways. Multitudinous impacts affecting multiple sectors and all countries are ‘systemic risks’ arising from highly inter-connected sectors and economies. COVID-19 is an example of this type of risk, which not only is a health risk but impacts on wider society and the whole economy. In addition to COVID 19, cascading risks explored by the analysis include the Fukushima Tsunami, the 2007/8 financial crisis, food, water scarcity in food and drink supply chains, climate conditions in the Syrian conflict and changes in Arctic shipping. Transition pathways for these risks include the movement of goods, people, information and IT. CCRA3’s analysis suggests the following:

- Systemic risks more commonly arise from a higher probability, lower impact event (or multiple events) which interact with human systems already under pressure from other drivers. Current adaptation largely considers risks primarily as hazards and treats domains separately and independently.
- Social amplification and risk interactions or cascades are often missing from narrow or sector-bound risk assessments relied on for decision-making. These may miss the bigger picture and underestimate the threat arising from the impacts of climate change.
- Disruptive events triggered by climate hazards are made more likely by trends in emissions driving climate change, and other socio-political and economic trends that affect exposure and vulnerability. As a result, systemic risks are more likely in the future than the past, and potentially more disruptive because all elements of the risk (hazard, exposure and vulnerability) are currently increasing.
- Current adaptation and policy planning largely considers risks primarily in terms of a focus on the ‘[black swan](#)’ hazards. For example disaster management, largely treating domains separately and independently. Systemic risk is rarely a focus of adaptation planning, or planning across the broader economy.

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## Benefits of further adaptation action in the next five years

Governance adaptability is needed to address systemic risks arising from the transmission of goods, people, finance and information from overseas, through:

- Assessment methods to identify the low probability and high consequence risks (or combinations of higher-probability events that may create systemic shocks) as well 'high probability' risks.
- Scenarios or storylines used to understand the full scope and intensity of a risk and to visualise how a risk may evolve beyond the range of experienced previous outcomes.
- Systemic risks can arise from one sector and transfer across sectors. Adaptation planning requires 'whole government' involvement in assessing and planning for risks and building more functional redundancy through diversity, distributed networks, substitutability and safety nets.

## 9. Next Steps

The [CCRA3 Technical Report](#) assesses the current and future risks to the UK from climate change. It does not recommend the specific adaptation actions that are needed to reduce risk or take advantage of opportunities in the future. The report identifies specific areas where further action is felt to be needed most urgently, based on the available evidence, and it discusses the benefits of taking further action. But an economic appraisal of different actions is out of scope of this assessment.

The task for the UK Government and devolved administrations, following the publication of this third CCRA Assessment, will be to weigh up the costs and benefits of different options and set objectives and actions in the next national adaptation programmes, from 2023 onwards. The cycle will then enter a new stage from 2027, when the fourth CCRA will be published.

Further outputs can be read alongside this summary, including a series of [17 briefings](#) that summarise the risks to key sectors (these being Agriculture and food, Business, Cultural heritage, Energy, Flooding and coastal change, Freshwater habitats, Health and social care, High temperatures, Housing, Land use/land use change and forestry, Marine and coastal environment, Telecoms and ICT, Terrestrial biodiversity, Transport, Water availability, Wildfire and Young people).

Other outputs include the Climate Change Committee’s statutory advice to Government on the CCRA, in the form of a separate CCRA3 Advice Report, drawing on the evidence presented in the Technical Report. There are also summaries for the other UK nations and other resources, all of which are available on the [UK Climate Risk website](#).

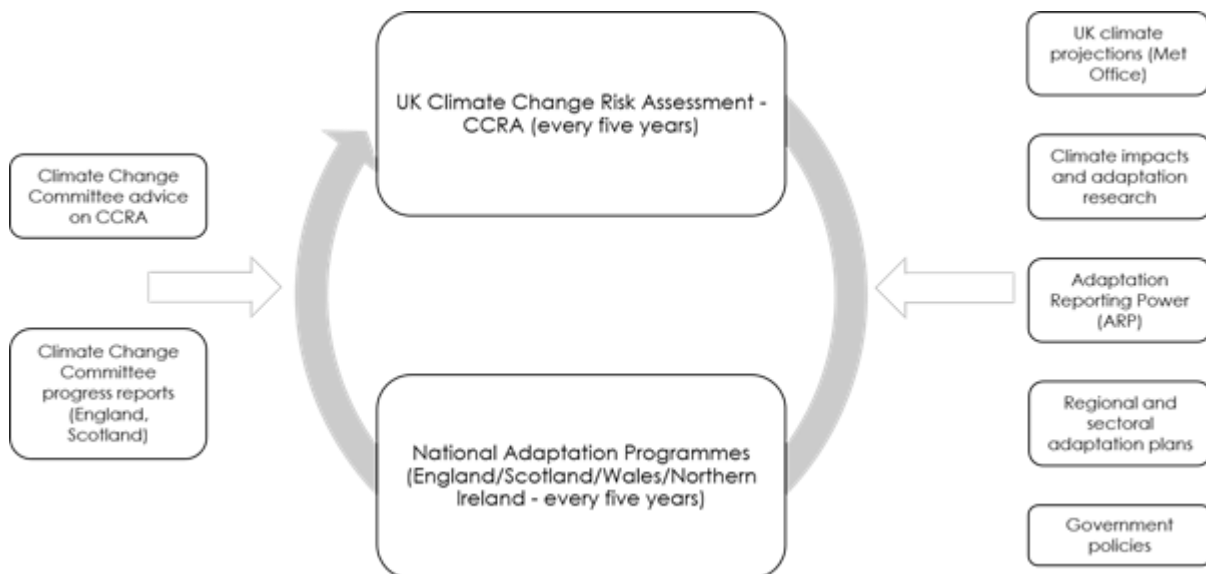


Figure 17: Summary of the UK adaptation policy cycle (taken from CCRA Technical Report Introduction).

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