March 2022

Is Scotland climate ready?

2022 Report to Scottish Parliament

Climate Change Committee

This page is intentionally left blank

Contents

Acknowledgements

The Committee would like to thank:

The team that prepared this report: This was led by Miriam Kennedy and included Richard Millar, Brendan Freeman, Cara Labuschagne, David Style, Gemma Holmes, Adam Gardiner and Helen Price.

Other members of the Secretariat who contributed to this report: Rose Armitage, Jaya Jassi, Marili Boufounou, Colm Williams, Bianca de Farias Letti, Jo Barrett, Tom Dooks, Mike Thompson and Chris Stark.

Organisations and individuals who contributed to the analysis: Adaptation Scotland (Sniffer), ClimateXChange, Forestry and Land Scotland, Kit England, NatureScot, Network Rail, Scottish Fire and Rescue Service, Scottish Forestry, Scottish Water, SEPA, Sustainable Scotland Network, Transport Scotland and officials across Scottish Government.

Organisations who provided images for the report chapters: Historic Environment Scotland, the Highland Council and the Metropolitan Glasgow Strategic Drainage Partnership (MGSDP).

The Committee

Baroness Brown of Cambridge DBE FRS
Chair, Adaptation Committee

Baroness Brown of Cambridge DBE FREng FRS (Julia King) is an engineer, with a career spanning senior engineering and leadership roles in industry and academia. She currently serves as Chair of the CCC's Adaptation Committee; non-executive director of the Offshore Renewable Energy Catapult; and Chair of the Carbon Trust.

Professor Michael Davies

Michael Davies is Professor of Building Physics and Environment at the UCL Institute for Environmental Design and Engineering (IEDE). At UCL his research interests relate to the complex relationship between the built environment and human wellbeing. He is also Director of the Complex Built Environment Systems Group at UCL and a member of the Scientific Advisory Committee of 'Healthy Polis'.

Professor Richard Dawson

Richard Dawson is Professor of Earth Systems Engineering and Head of Water in the School of Engineering at Newcastle University. Over the last two decades his research has focused on the analysis and management of climatic risks to civil engineering systems, including the development of systems modelling of risks to cities, catchments and infrastructure networks

Ece Ozdemiroglu

Ece Ozdemiroglu is an environmental economist and the founding director of eftec (Economics For the Environment Consultancy). Her work uses economic value evidence for natural capital accounting and economic appraisal. Ece is also the convenor of the British Standards Institute's Assessing and Valuing Natural Capital Committee, economics Lead of the Valuing Nature Programme and a member of the Natural Capital Initiative steering group.

Rosalyn Schofield LLB

Rosalyn Schofield is a solicitor. She is Director of Company Secretariat at Associated British Foods plc, where she has global responsibility for the environmental sustainability and impact of the business. Rosalyn is also a Trustee at Regent's University and Chair of the Audit and Risk Committee there as well as at the CCC.
She has previously worked as Legal Director at JD Wetherspoon plc and was a commercial property lawyer in private practice.

Professor Kate Jones
Expert Adviser to the Adaptation Committee

Kate is Professor of Ecology and Biodiversity at University College London. Her work focuses on crossing disciplinary boundaries to address critical global challenges, especially at the interface of ecological and human health. Prof Jones has made key advances in monitoring the status and trends in biodiversity and particularly in modelling and forecasting zoonotic disease outbreaks in humans (Ebola, SARS), breaking down traditional barriers between ecology, climate change and public health to inform global policy.

Executive summary

In this report we assess adaptation progress in Scotland and the Scottish Government's second Scottish Climate Change Adaptation Programme (SCCAP2).

This report sets out the Climate Change Committee's (CCC) independent assessment of progress in adapting to climate change in Scotland. Scotland has set out a far-reaching vision for how it wants to build resilience to a changing climate through its second Scottish Climate Change Adaptation Programme (SCCAP2). Whilst this vision is welcome, our assessment of progress in adaptation across society indicates that more needs to be done to ensure that the vision translates into actions commensurate with the size of the challenge.

The key messages in our assessment are:

- **Build on the vision in the SCCAP.** The qualitative outcomes for successful adaptation identified in the SCCAP are a useful start in building a vision of a well-adapted Scotland. However, for these outcomes to drive effective action on the ground, they need to be operationalised through clear, time-bound and quantitative targets, with clear Government ownership. This is needed to provide a framework that can effectively hold Government to account on its adaptation commitments.

- **Progress in delivering adaptation has stalled.** Available evidence indicates that across most sectors progress in delivering adaptation has stagnated, despite a limited number of areas where good progress is being made. Opportunities to embed adaptation actions across the full range of Government activities are not currently being taken.

- **Monitoring and evaluation of adaptation is urgently needed.** There is a critical gap in the provision of effective monitoring and evaluation systems for adaptation in Scotland, meaning that changes in aspects of many climate risks are largely unknown. For the SCCAP to be effective these systems need to be created and implemented with urgency.

- **There are opportunities to raise the level of Scotland's adaptation response.** Across Scotland there are numerous local-level examples that can form the template for a stronger and larger-scale adaptation response. There are also opportunities to extend Scotland's leading position in considering justice implications of climate policy to adaptation and action to improve climate resilience can be aligned with wider policy priorities emerging from the COVID-19 pandemic.

The rest of this executive summary is laid out in four sections:

1. Scotland's climate is changing and poses risks to society

2. Scotland's adaptation programme sets a vision but needs specific objectives and actions

3. Progress in delivering adaptation has stalled

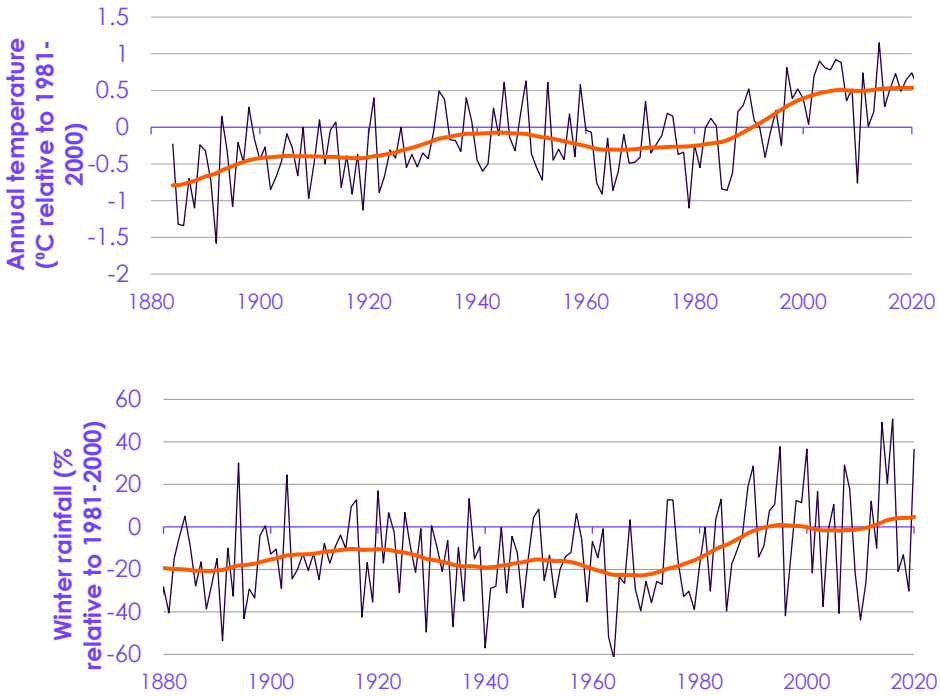
4. Priorities for strengthening Scotland's adaptation response

1. Scotland's climate is changing and poses risks to society

Climate changes are already being seen in aspects of Scotland's climate.

The evidence of climate change in Scotland is now clear. Compared to just 30 years ago, the average temperature in Scotland has risen by 0.5ºC, Scottish winters have become wetter (by around 5% - with considerable year-to-year variability) and the sea level around the coast of Scotland has been rising by 10 – 30 mm per decade (Figure 1).

Figure 1 Observed climate change in Scotland



Source: CCC analysis; HadUK-Grid dataset, Kendon, M. et al. (2020) *State of UK Climate 2019*. International Journal of Climatology, 40 (S1), 1-69.
Notes: Annual data is shown in all panels. The orange line is a moving 30-year triangular averaging window (reflecting at ends of timeseries).

More change in Scotland's climate will occur and must be prepared for.

These changes are now having clear impacts on Scotland's people and ecosystems and further climate change in Scotland over the coming decades is inevitable no matter how rapidly global greenhouse gas emissions are reduced. Beyond mid-century the amount of additional change still to come depends on the success of global emissions reduction efforts.

Even with successful global efforts in line with the Paris Agreement, over the coming decades temperatures in Scotland will continue to increase; summers will likely become drier on average whilst winters become wetter and sea levels continue to rise. These changes will lead to risks that will have impacts on all areas of Scotland's society and landscapes:

Impacts will be felt right across Scotland and Scottish society without additional adaptation.

- **Natural Environment:** Future climate changes will have impacts on Scotland's environments on land and in water. An increase in the range, quantities and consequences of pests, pathogens and invasive species as the climate warms could have significant negative economic consequences for Scottish agriculture and for forestry (which is worth close to £ 1 billion to Scotland's economy each year). A significant proportion of agricultural land in Scotland has been impacted by fluvial flooding in recent years, with the area of best quality agricultural land at risk from fluvial flooding in Scotland currently projected to increase by 26% by the 2050s.

- **Infrastructure:** More frequent flooding and increased coastal erosion will cause damage to infrastructure services, including energy, transport, water and Information and Communication Technologies (ICT). For example, over 800 km of railway is already exposed to significant surface water flooding risk in Scotland. This could increase by over 60% by 2100 under a high-end global warming scenario. Recent storms across Scotland have also highlighted the vulnerability of infrastructure systems to extreme weather and the increasing exposure of our society to weather-related failures of the electricity system.

- **Built environment and health:** Increasing frequency and intensity of heatwaves will pose risks to people's health and wellbeing. Heat related deaths in Scotland could rise to well over 100 a year by 2050. Significant increases in the severity and frequency of flooding of homes and businesses are expected, and in particular locations sea level rise could require communities to relocate further from the coast due to extremely high costs of coastal flooding and coastal erosion protection.

- **International and supply chain impacts:** Like the rest of the UK, Scotland's people and businesses are exposed to risks from climate change happening elsewhere in the world. These include risks to food imports, and disruption to international supply chains.

The Independent Assessment of UK Climate Risk and its underpinning Technical Report provide an in-depth assessment of the increasing urgency of these risks in Scotland and the need for adaptation. Adequately addressing these risks needs a proactive, well-designed, and effectively delivered approach from Government and wider society.

It sets a vision but needs specific objectives and actions.

The SCCAP contains a qualitative vision for a well-adapted Scotland and considers risks from climate change abroad.

The second SCCAP sets out the Scottish Government's intentions to support Scotland's people and ecosystems to adapt to climate change. The programme identifies seven qualitative 'outcomes' aiming to ensure that Scotland is resilient to future climate conditions (Figure 2).

Figure 2 Outcomes of the second Scottish Climate Change Adaptation Programme

1. Communities
Our communities are inclusive, empowered, resilient and safe in response to the changing climate

2. Climate Justice (including health)
The people in Scotland who are most vulnerable to climate change are able to adapt and climate justice is embedded in climate change adaptation policy

3. Economy
Our inclusive and sustainable economy is flexible, adaptable and responsive to the changing climate

4. Supporting systems
Our society's supporting systems are resilient to climate change

5. Natural Environment
Our natural environment is valued, enjoyed, protected and enhanced and has increased resilience to climate change

6. Coastal and Marine Environment
Our coastal and marine environment is valued, enjoyed, protected and enhanced and has increased resilience to climate change

7. International Networks
Our international networks are adaptable to climate change

Source: Scottish Government (2019) *Climate Ready Scotland: climate change adaptation programme 2019-2024.*

These qualitative goals provide a useful vision of a well-adapted Scotland. In particular, the inclusion of international dimensions of climate risks (the effects that climate change occurring elsewhere in the world can have in Scotland) is a welcome recognition of the need to consider Scotland's place in an increasingly interconnected world.

This vision is not sufficient to drive effective adaptation in isolation.

However, the SCCAP outcomes are insufficient, by themselves, to drive the necessary adaptation response and do not enable the Scottish Government to monitor progress on delivery of their own ambitions and policy objectives.

More needs to be done to define a set of objectives and a plan for a 'well-adapted Scotland' that will drive delivery:

Quantified goals for adaptation are needed to enable Government to be held to account on delivery.

- **Quantified targets for climate resilience:** The Scottish Government should set specific and quantified targets for levels of resilience across Scottish society under each top-level SCCAP outcome. This would allow the Scottish Government to measure progress against targets and increase accountability on their delivery.

- **Linkages between SCCAP activities and outcomes:** Each outcome under the SCCAP lists a set of activities and actions beneath it. However, it is currently not clear how the implementation of these activities will lead to the overall outcome being achieved. A clearer framework is needed to link these activities to outcomes. This would also enable better assessments of whether adaptation actions are happening at sufficient scale as well as where key gaps exist.

- **Clear ownership for outcome delivery:** Currently there is not sufficient clarity regarding which part of the Scottish Government has overall responsibility for delivering on each SCCAP sub-outcome. Ownership of each outcome should be clearly assigned to a specific part of Government to ensure accountability.

The lack of a monitoring and evaluation system is limiting the effectiveness of the SCCAP and must be urgently addressed now.

- **Monitoring and evaluation must be implemented with urgency:** Monitoring and evaluation needs to be prioritised and addressed urgently as without this the SCCAP risks being ineffective.

  – The Committee previously recommended a monitoring and evaluation framework be put in place for the second SCCAP. This has not been implemented despite being planned and the current annual progress reports by the Scottish Government do not provide a sufficiently in-depth assessment of progress.

  – Implementing an effective monitoring and evaluation framework is critical to ensuring that adaptation activity is leading to real reductions in the vulnerability to climate risks and towards achieving the SCCAP target outcomes.

  – The Scottish Government's comprehensive monitoring and evaluation framework developed for reaching greenhouse gas emission reduction goals in Scotland should serve as a benchmark that needs to be replicated for tracking adaptation progress.

Developments to the SCCAP structure should be made within this SCCAP cycle.

These developments should be implemented within this SCCAP cycle. Waiting until the next SCCAP (expected in 2024) is too late to implement needed changes to support the large-scale delivery of adaptation actions in Scotland.

3. Progress in delivering adaptation has stalled

Frameworks for adaptation policy are valuable only if they lead to sufficient action to help limit climate risks.

In most areas adaptation progress has stagnated.

Our assessment indicates that adaptation action is not being implemented with sufficient scale and urgency to address fully the climate risks to Scotland (Figure 3). We find that progress in adapting to climate change has stagnated across all sectors, despite a small number of priority areas where good progress has been made.

- Natural Environment:
  - Farming: There is not credible planning to adapt farmland habitats and species to a changing climate and there are insufficient data to understand how the risk is being managed. This is despite farmland making up 73% of the land area of Scotland.
  - Other terrestrial habitats and species: Rates of peatland restoration, which is needed to make these habitats resilient to climate risks, are falling well short of the Scottish Government's targets.
  - Fresh water: The latest River Basin Management plans from Scottish Environmental Protection Agency (SEPA) do not include consideration of future climate change, despite the potential for climate change to affect freshwater habitats and species, commercial fisheries and aquaculture yields.
  - Marine: There have been significant increases in marine protected areas around Scotland, but a mixed picture for the condition of marine mammals, birds, and fish.
  - Forestry: Progress has been made in planning for adaptation in commercial forestry, as Forestry and Land Scotland have developed an Adaptation Action Plan with 'SMART' objectives and guidance for staff.
- Infrastructure:
  - There is insufficient inclusion of adaptation in plans for many key infrastructure sectors including: ports, airports, telecoms, digital and ICT infrastructure despite the climate risks they face.

A growing dependence on electricity increases necessity of building an electricity system resilient to future weather.

  - The gap in planning for maintaining a weather-resilient energy system increasingly threatens the delivery of the Scottish Government's ambitious greenhouse gas emissions reduction targets. Increasing reliance on electricity on the path to Net Zero emissions magnifies the consequences of power outages.
  - Infrastructure interdependencies can multiply the impacts of individual weather events, as recently seen with Storm Arwen. Interdependencies are not yet being meaningfully incorporated into adaptation planning.

  - In some areas of infrastructure there has been good progress in adaptation planning. A new adaptation strategy is being developed by Transport Scotland, and Scottish Water is currently developing a climate change risk assessment.

- Built Environment:

  - Flooding prevention: The latest Scottish flood risk management plans do not include specific or measurable objectives for reducing flood risk and the monitoring and evaluation frameworks are insufficient for all types of flooding. All sources of flooding and coastal erosion risk need to be managed in a co-ordinated way.

There is a critical lack of data on properties being built in flood risk areas.

  - Planning: Data are not being collected on the number or location of new properties being built in flood risk areas, making it difficult to assess how effective the planning framework is in restricting development in these areas.

  - Coastal protection: The majority of Scotland's shoreline is not covered by Shoreline Management Plans, meaning most local authorities do not have a plan for coastal erosion risk.

Important steps forward have been made in considering a changing climate in emergency response service planning.

  - Emergency response: There has been good progress on considering adaptation within emergency planning and response. The Scottish Fire and Rescue Service now recognises the increasing risks of flooding and wildfires in Scotland and is working to assess community risks, address data gaps and improve performance monitoring for these types of events.

- Health:

  - Heat: The increasing frequency and intensity of extreme high temperatures are not being adequately considered in key housing and buildings strategies, despite opportunities to tackle overheating alongside energy efficiency measures. However, implementing the currently proposed changes in building regulations to reduce overheating risk and improve ventilation would be a positive step towards addressing this.

  - Vector-borne diseases: There are no plans for responding to climate change-induced increases in vector-borne diseases, such as Lyme disease, despite notable increases in cases in recent years. As with the other sectors, there are insufficient data to assess whether the risks are being effectively managed.

- Business:

  - Supply chains and water use: There are no overarching plans and limited actions to prepare Scotland for supply chain disruption from climate change. There are also no measurable targets for reducing water demand by industry, despite risks of future droughts, and abstraction data are not published.

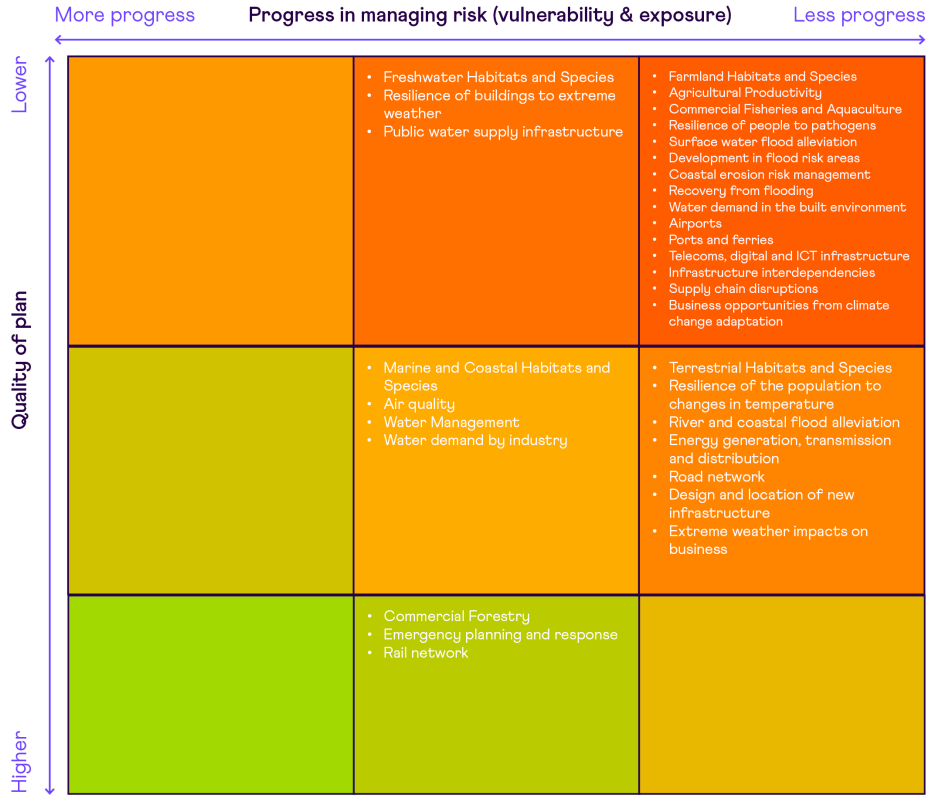
  - Opportunities: The economic opportunity of adapting to climate change is not well known, although NatureScot have started working on this with their Nature-based Jobs and Skills Action Plan. The plan includes estimates of the size of the nature-based jobs sector in

Scotland and identifies actions to realise the growing opportunity in areas like peatland and woodland restoration, natural flood management.

A lack of relevant data is a major barrier to better understanding how climate risks are changing in Scotland.

Across these sectors there is a critical lack of relevant datasets to assess fully adaptation progress, making it very difficult to quantify accurately how important aspects of climate risks, exposure and vulnerability are evolving in Scotland.

Figure 3 Scoring of progress in adaptation priority areas for Scotland



Source: CCC analysis.

Our assessment of progress finds that adaptation planning is currently under-resourced across Scottish Government and in implementing agencies. An example of this was the delay in the publication of the SEPA flood risk management plan updates in part to deal with consequences of current flooding emergencies. Sufficient resourcing at Government and implementing agency levels is required to ensure progress is made on adaptation in the context of growing climate risks.

Scottish Government structures could support integration of adaptation across Government but are not currently being utilised.

The structure of the Scottish Government can be conducive to cross-Government working, with Minsters having briefs extending across traditional directorates, but this is not yet being taken advantage of to drive cross-Government working on adaptation. Expanding the Net Zero, Energy and Transport ministerial portfolio to explicitly include a mandate on building resilience to future climate change would help raise the profile of adaptation within Government.

4. Priorities for strengthening Scotland's adaptation response

Our assessment suggests four elements for strengthening Scotland's adaptation response.

Lessons from effective local adaptation programmes can help raise overall efforts.

a) Learning from local excellence

Across Scotland, there are many examples of good local adaptation actions happening on the ground, in communities, cities and regions. For example:

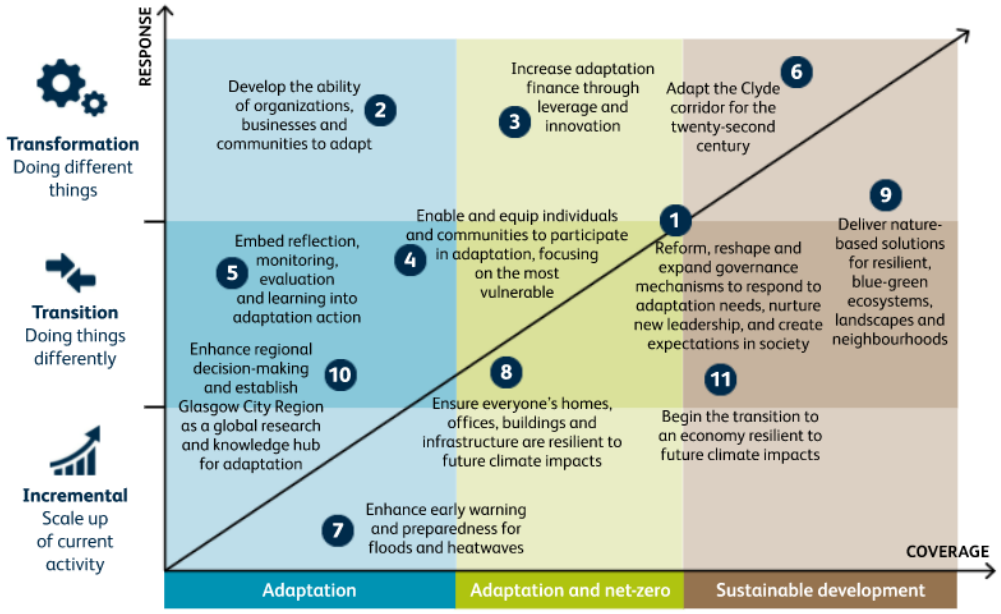
- Glasgow's Climate Adaptation Strategy and Action Plan includes targets for 2025 to close its adaptation finance gap (of £184 million per year) and involve 125 new organisations, community groups and businesses in supporting the Glasgow City Region to adapt (Figure 4). The plan sets out a clear vision of what a well-adapted Glasgow will look like and considers both incremental and transformational adaptation measures. This vision sits on top of a full theory of change with 11 interventions and 16 flagship actions to realise the vision over time.

- Edinburgh City Council is implementing a project to develop a network of green and blue infrastructure across the city, working with stakeholders and specialists to identify opportunities to deliver multiple environmental, social and economic benefits. For example, green and blue infrastructure can be used to reduce surface water flood risk, improve biodiversity, improve water management, encourage more active travel and reduce the urban heat island effect.

- The Outer Hebrides Community Planning Partnership has worked with the local community to produce a climate change risk assessment for the Outer Hebrides, prioritising risks and assigning urgency scores through a participatory, place-based approach. This included community mapping on the islands of Uist and generating island-specific adaptation recommendations with a focus on locally driven solutions.

These examples of local excellence can serve as templates for effective action. Efforts should be made to understand the features that have made these successful and how they could be replicated at scale and supported by policy, right across Scotland.

Figure 4 Interventions included in the Glasgow Climate Adaptation Strategy and Action Plan



Source: Climate Ready Clyde (2021) *Glasgow City Region Climate Adaptation Strategy and Action Plan*.

b) Extending the focus on Net Zero to include climate adaptation

The growing recognition in decision making of the need to consider reaching Net Zero needs to be extended to adaptation.

Ambitious greenhouse gas emissions reductions targets have been set by the Scottish Government and are raising awareness of the need to reduce emissions right across Scottish society and the Scottish economy. This growing awareness of the need to tackle climate change must now extend to climate change adaptation, which will be required no matter how rapidly Scotland reduces its own greenhouse gas emissions. This means fully seizing opportunities to address linked challenges for emissions reduction and climate adaptation that are currently not being taken (e.g. using the Housing to 2040 Strategy to tackle both energy efficiency and overheating in Scottish homes together), and broadening sector climate change plans to go beyond considering emissions reduction alone (e.g. fishing sector plans which discuss how to reduce emissions from vessels, but not changes in fish stocks due to climate).

Scotland can lead the way in incorporating fairness into adaptation policy.

c) Building climate resilience in a fair way

Scotland faces the challenge of building resilience to climate impacts whilst delivering a sustainable and fair recovery from the COVID-19 pandemic. Like the transition to Net Zero, resilience to current and future climate change needs to be delivered in a fair way to ensure that the benefits are felt across the whole of society. Box 1 presents our principles for ensuring adaptation is fair through design, implementation, monitoring and evaluation of policies – produced as part of a briefing on The Just Transition and Climate Change Adaptation published alongside this report.

We provide a set of principles for how fairness and inequalities can be included within adaptation policy design.

Box 1
Principles for addressing inequalities and embedding fairness in adaptation policy design

As part of this assessment, we highlight six principles that can enable adaptation policy to consider inherent inequalities and contribute to a just transition:

- Acknowledge that climate change impacts different groups in society differently.
- Acknowledge that adaptation or other policy goals can introduce unintended distributional bias.
- Set sufficiently broad 'system boundaries' for policy assessment.
- Engage extensively and regularly with local stakeholders from the start.
- Rigorously track, evaluate, and communicate distributional outcomes.
- Implement policy flexibly and iteratively, allowing unanticipated effects to be identified and corrected over time.

These principles can serve as a guide for policy design, implementation and evaluation throughout this SCCAP and beyond to place fairness at the heart of adaptation policy efforts in Scotland.

Source: CCC (2022) *The Just Transition and Climate Change Adaptation.*

The levers to do more on adaptation action are within the Scottish Government's hands.

d) Raising ambition now

The next few years represent a critical period to avoid further impacts of climate change and the cost of locking in infrastructure and technology that are not resilient to unavoidable climate risks. Most of the levers needed to implement this step change in delivery are within the hands of the Scottish Government and should be implemented within this SCCAP cycle. Action to improve climate resilience can be aligned with wider policy priorities emerging from the COVID-19 pandemic. In particular, the possible shift to more regular working from home for certain occupations following the pandemic highlights the critical importance of making sure that Scotland's digital infrastructure is robust to climate impacts and that homes are comfortable in periods of extreme heat.

The rest of this report is set out in six chapters:

1. Introduction and assessment framing
2. Natural Environment
3. Health
4. Built Environment
5. Infrastructure
6. Business

We provide a detailed set of recommendations across each sector in a separate annex to this report as well as in the sectoral assessment chapters. A dedicated briefing on The Just Transition and Climate Change Adaptation is published alongside this report.

Chapter 1

Introduction and assessment framework

Summary and key findings

This chapter introduces our assessment of the second Scottish Climate Change Adaptation Programme (SCCAP). It summarises the evidence of past and expected future climate change in Scotland, the assessment framework that we use across this report, and the social context for implementing climate change adaptation in Scotland.

The key messages of this chapter are:

- **Climate change is already happening in Scotland and will continue over coming decades.** Temperature and rainfall patterns are already changing in Scotland. The climate will continue to change over the coming decades in all future scenarios, with increasing risks across the Scottish economy and ecosystems if additional adaptation actions are not taken.

- **We assess progress in both planning for a changing climate and in managing climate risks.** We look at adaptation priority areas across all aspects of society and ecosystems to assess each one against criteria for a good adaptation plan and clear evidence that actions are leading to reductions in climate risk, exposure, or vulnerability to climate change.

- **A monitoring and evaluation system for the SCCAP is urgently needed.** Assessing evidence of the management of climate risks in Scotland is currently being held back by the lack of an effective monitoring and evaluation system to track the implementation and effectiveness of adaptation. This needs to be implemented with urgency.

- **Delivering and sustaining adaptation action over time requires alignment and integration with other public priorities.** As policy priorities for recovery from COVID-19 shift in response to the changing nature of the pandemic, there are opportunities to ensure that a changing climate is incorporated into planning for some of the potentially longer-lasting changes that the pandemic has triggered (e.g. more working at home). Continuing to raise public and business understanding of climate risks is also key to sustaining adaptation action over time and across wider society.

The chapter is set out in three sections:

1. Scotland's changing climate

2. The assessment framework for this report

3. The societal context for adaptation action in Scotland

1. Scotland's changing climate

Evidence of climate change in Scotland is becoming clearer. In this section we summarise observed changes in Scotland's climate and further changes that are expected over coming decades together with the risks these changes will create to Scotland's economy, landscapes, and society.

a) Observed changes

The latest observations of Scottish weather and climate continue to document several clear trends in aspects of Scottish climate (Figure 1.1):

- **Warmer average temperature**. Scotland's annual average temperature is now around 0.5ºC warmer than it was around 30 years ago (an average of the 1981 - 2000 period). Scotland's 10 warmest years on record have all occurred since 1997.[1]

- **Higher average sea level.** Sea levels are rising around the Scottish coast. Depending on location, trends in sea level over the historical period have ranged from 10 – 30mm per decade.[2]

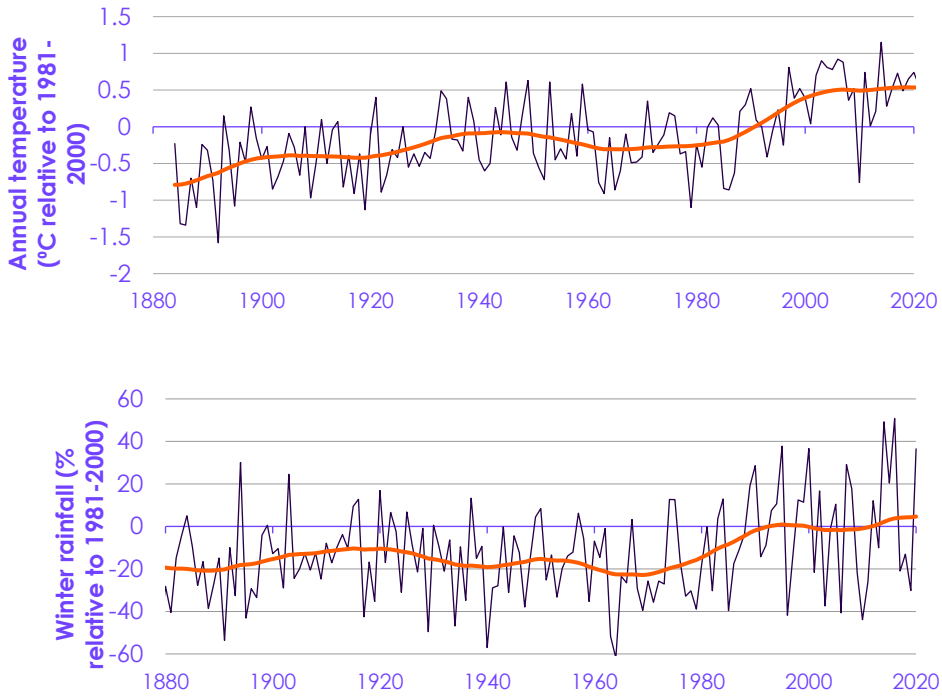
Scotland's climate has already changed, seeing warmer average temperatures, higher sea levels, increased rainfall and more sunshine.

- **Increased rainfall.** There has been an increase in rainfall over Scotland in the past few decades (with an increasing proportion of rainfall coming from heavy rainfall events). The annual average rainfall is currently around 1.5% wetter than the 1981-2000 average, with winters 4.5% wetter.*[3] Recent summers in Scotland have been wetter than average, despite an expected shift to drier summers in the future.

- **Sunshine.** The most recent decade in Scotland has been around 5% sunnier than over 1981 – 2000 (with increases largely confined to winter and spring), however the causal link between this trend and human-induced climate change currently remains under investigation, with possible links to changes in aerosol emissions.[4]

* Relative to the 1961-1990 reference period, winters are now around 21% wetter, with annual average rainfall around 9% greater.

Figure 1.1 Observed climate change in Scotland



Source: CCC analysis; HadUK-Grid dataset, Kendon, M. et al. (2020) *State of UK Climate 2019*. International Journal of Climatology, 40 (S1), 1-69.
Notes: Annual data is shown in all panels. The orange line is a moving 30-year triangular averaging window (reflecting at ends of timeseries).

Signals of climate change may be emerging in other climate variables, but the strong annual and decadal variability in Scotland's weather and climate still prevents their clear detection. These include changes in storminess, however recent extreme weather events in Scotland have demonstrated the significant impacts storms can have (Box 1.1).*

Box 1.1
Extreme weather and climate events in Scotland during 2021 to early 2022

- **Storms and low temperatures in early 2021.** The UK experienced a week of severe winter weather from 7 to 13 February 2021. Storm Darcy brought persistent snow showers which resulted in significant accumulations across eastern Scotland. Much of eastern Scotland experienced deep lying snow with depths in some places of 20 to 30cm or more. The night of the 11th of February saw temperatures fall to between -10 to -15°C across eastern Scotland, and three stations falling below -20°C. At Braemar, -23.0°C was recorded, the UK's lowest temperature since December 1995.
- **Heavy rain in October.** A major incident was declared in the Borders town of Hawick due to rising water levels on the River Teviot, with plans in place to evacuate local residents.
- **Strong winds in late 2021.** Storm Arwen brought severe winds across the UK. The storm brought northerly winds gusting widely at over 60Kt (69mph). The highest gust speed was 85Kt (98mph) at Brizlee Wood, Northumberland. This was one of the most powerful and damaging winter storms of the latest decade.

* Evidence from the latest generation of climate models produced by the UK Met Office, which have improved representation of Jetstream variability, suggests a possible shift to more stormy winters on average in the future.

- **Exceptionally mild new year 2022.** Over the New Year period from 30 December 2021 to 2 January 2022 Scotland experienced a spell of exceptionally mild weather for the time of year. Temperatures reached 15.9°C at Achnagart in Glenshiel, Kyle, on New Year's Day which broke the previous record of 14.5°C, which was previously registered at Inverurie, Aberdeenshire, in 1992.
- **Storms in early 2022.** Storms Malik and Corrie arrived in quick succession, bringing damaging north-westerly winds to northern Scotland. Falling trees resulted in a loss of power supplied to tens of thousands of homes in areas including Aberdeenshire. There was major disruption to rail services in Scotland, and difficult driving conditions. Ferry sailings in Scotland were delayed or cancelled.

Source: Met Office (2022) *Case studies of past severe weather events.* https://www.metoffice.gov.uk/weather/learn-about/past-uk-weather-events

b) Future projected climate changes

Future changes in Scottish weather and climate depend on both the amount of future global greenhouse gas (GHG) emissions and on how the climate responds to these emissions. Although the latest evidence indicates that there is expected to be no significant future global warming 'locked-in' from past emissions, further changes in the global and Scotland's climate by 2050 is inevitable as the world will take several decades, at the very least, to reach Net Zero emissions. Longer-term (post-2050), changes in Scotland's climate will largely depend on how rapidly global emissions are reduced and then brought toward Net Zero.

The latest climate projections indicate significant further changes in the Scottish climate: [5]

In the future, annual temperatures in Scotland are projected to rise further, rainfall will likely increase and extreme weather events will become more likely.

- **Temperature:** Annual temperatures in Scotland are expected to rise by around 1°C by 2050 (relative to a 1981-2000 baseline) and between 1°C and 2°C by the end of the century, depending on global efforts to reduce greenhouse gas emissions. Risks associated with rising temperatures, such as more extreme heatwave events causing impacts on people's health and wellbeing, are likely to become more prevalent as a result, with their magnitude depending on the degree of change that is experienced.

- **Rainfall:** In winter, rainfall is expected to increase by approximately 7% by the 2050s and by 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 7% by the 2050s and by 12% to 16% by the 2080s. Periods of water scarcity are projected to become more prevalent under these scenarios, leading to possible implications in agriculture and industry.

- **Weather extremes:** The frequency and intensity of extreme temperature and rainfall events is also likely to increase in future, with the extent of change depending on global efforts to reduce greenhouse gas emissions. At 2°C of global mean warming, hot summer days will warm by 1 to 1.5°C across Scotland in the 21st century, similar to the change for summer average temperatures.[6] As well as winters becoming wetter overall, the intensity of rainfall is also projected to increase throughout the year. Despite overall summer drying, when it does rain rainfall will be more intense, leading to possible surface water flooding risks.

- **Sea level rise:** Using scenarios for Edinburgh, sea level is expected to rise by between approximately 12 and 18cm by 2050 (relative to a 1981-2000 baseline) and by approximately 23 to 54cm by 2080, and depending on global efforts to reduce greenhouse gas emissions. Such rises would lead to an increase in likelihood of associated risks, such as flooding of coastal communities. These rates of sea-level rise are lower than for other more southerly UK locations. This is due to the effects of land rebound from the last ice age being larger towards the north of the UK.

Scotland's weather and climate will also continue to be highly variable, with large fluctuations (year-to-year and over longer periods) around the long-term trend.

c) Climate risks in Scotland

The Independent Assessment used to help inform the third UK Climate Change Risk Assessment (CCRA3) assesses 61 risks and opportunities from climate change to Scotland, including to business, infrastructure, housing, the natural environment, our health, and risks from the impacts of climate change internationally.

The UK's third climate change risk assessment identified 61 risks, many of which scored high magnitude for Scotland.

Many of the areas of climate risk highlighted in CCRA3 have particular relevance to Scotland, due to the specifics of its geography.[7] For example:

- Scotland's rivers and lochs contain 90% of the UK's surface fresh water.[8]
- Scotland has the highest proportion of woodland area in the UK and peatlands cover more than 20% of Scotland's land area.[9] Forestry contributes nearly £1 billion to Scotland's economy every year.[10]
- Scotland has a long coastline with 19% of it having potential to erode. Between a half and a third of all coastal buildings, roads, rail, and water networks lie in these erodible sections.[11]
- In more remote parts of Scotland a significant minority of people (e.g., 34% in Argyll and Bute) rely on private water supplies which are especially vulnerable to small variations in the climate such as increasing temperatures and changing rainfall patterns, as they generally come from surface waters.[12]
- In Scotland's rural areas transport infrastructure frequently follows natural features, such as steep sided river valleys which can be prone to landslide risk which could increase with a wetter future winter climate.

The Committee identified priority areas for adaptation action in the next two years.

The CCRA3 identified several priority areas for Scotland where more action is required now to address them, after considering existing adaptation responses:

- 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. A significant proportion of agricultural land in Scotland has been impacted by fluvial flooding in recent years. By the 2050s the area of best quality agricultural land at risk from fluvial flooding in Scotland is projected to increase by 26%.

- The risk of climate change impacts, especially more frequent flooding and coastal erosion, causing damage to infrastructure services, including energy, transport, water and Information and Communication Technologies (ICT). For example, over 800 km of railway is already exposed to significant surface water flooding risks in Scotland. This could increase by over 60% by 2100 under a high-end global warming scenario.

- The impact of extreme temperatures, high winds and lightning on the transport network. Recent storms across Scotland have also highlighted the vulnerability of infrastructure systems to extreme weather and the increasing exposure of our society to weather-related failures of the electricity system.

- The impact of increasing high temperatures on people's health and wellbeing and changes in household energy demand due to seasonal temperature changes. Heat related deaths in Scotland could rise to well over 100 per year by 2050.

- Increased severity and frequency of flooding of homes, communities and businesses. Flooding was highlighted as the costliest risk to business in Scotland today.

- The viability of coastal communities and the impact on coastal businesses due to sea level rise, coastal flooding and erosion. In specific locations a rise in sea level could require communities to relocate further from the coast due to extremely large costs of coastal flooding protection.

- Damage to our cultural heritage assets as a result of temperature, precipitation, groundwater and landscape changes.

- Impacts from climate change happening elsewhere in the world that may affect the UK, such as: risks to food imports 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.

There are adaptation actions available to respond to climate risks, which need to be supported by data and research.

These risks extend across the full range of sectors in the Scottish economy and will touch on many aspects of Scotland's way of life and landscapes. Limiting the adverse effects of these climate changes will require a proactive and whole-of-society approach for Government, but also businesses and residents. The evidence summarised by CCRA3 indicates that there is a large range of adaptation options available to help address these risks ranging from engineering solutions, nature-based solutions, new technologies, and institutional, behavioural and financial adaptation. These all need to be underpinned by good data and R&D to support evidence-based and effective action. In many cases, adaptation actions have been shown to have positive benefit to cost ratios (on a societal basis), even when considering the direct reduced impacts from climate change impacts alone.[13]

SCCAP2 recognises the potential impacts from climate change happening overseas as well and include some positive actions to address these.

Scotland will also face impacts from climate change occurring elsewhere in the world, due to the increasing global interconnectedness. These impacts will be felt through international supply chains, global markets, and potential impacts on global institutions and frameworks over the longer term. The SCCAP recognises the need to consider international climate risks as part of effective adaptation and Scotland has increased its Climate Justice Fund (in 2021) to provide £36 million per year of climate finance (over this parliament) to support developing countries in tackling climate change, including funding for loss and damage of unavoidable climate impacts.

2. The assesment framework for this report

This section sets out the purpose of this report and our framework for assessing progress in adaptation across Scotland.

a) Purpose of this report

The Climate Change (Scotland) Act requires an independent assessment of progress made towards implementing the Scottish Climate Change Adaptation Programme (SCCAP) within two years of the programme being published. The Committee's final assessment in 2019 of the first SCCAP considered how the SCCAP and other actions were changing vulnerability and exposure to climate risks in Scotland.[14] That report made a set of recommendations for the second iteration of the Programme, known as SCCAP2, which was published later in 2019. This report is the CCC's first assessment of the SCCAP2.

This report was commissioned by the Scottish Government to provide an independent assessment of progress on adapting to climate change in Scotland.

In December 2021, the CCC published its tenth annual report on progress in reducing emissions in Scotland.[15] Progress in reducing greenhouse gas emissions is not covered as part of this report.

The Scottish Government requested the CCC to focus on several areas as part of this assessment:

- Assessing the progress made towards implementing the objectives, proposals and policies set out in the SCCAP.
- Priority areas for strengthening Scotland's near-term response to climate change risks as part of a resilient, green recovery from the COVID-19 pandemic.
- Advice on the role of adaptation in a Just Transition.

The chapters of this report and its associated annexes provide our response to all aspects of this request. A second assessment of progress in implementing this SCCAP, including advice for the third iteration of the programme, is expected in 2023.

b) The assessment framework for this report

For assessing progress in adaptation across Scotland we use a framework aligned with that used to assess progress in the CCC's 2021 progress report for England.[16]

Our assessment framework is divided into different sectors and priority areas for adaptation.

We assess progress in 34 individual adaptation priority areas, grouped into sectors of natural environment, health, built environment, infrastructure, and business. In each of these individual priority areas relevant climate risks and adaptation actions from the most recent CCRA are identified to assess progress against. These adaptation priority areas cut across the SCCAP outcomes – often with priority areas relevant to multiple SCCAP outcomes. A mapping between SCCAP outcomes and relevant adaptation priority areas is shown in Table 1.1.

Table 1.1
SCCAP2 outcomes mapped to assessment priority areas

SCCAP2 Outcome	Relevant priority areas	Planning score	Risk management score
1. Our communities are inclusive, empowered, resilient and safe in response to the changing climate • 1.1 People in Scotland's diverse communities are informed, empowered and adapting to climate change • 1.2 Scotland's buildings and places are adaptable to Climate Change	River and coastal flood alleviation (BE)	Medium	Low
	Surface water flood alleviation (BE)	Low	Low
	Development in flood risk areas (BE)	Low	Low
	Resilience of buildings to extreme wind and rain (BE)	Low	Medium
	Water demand in the built environment (BE)	Low	Low
	Recovery from flooding (BE)	Low	Low
	Emergency planning and response (BE)	High	Medium
The people in Scotland who are most vulnerable to climate change are able to adapt and climate justice is embedded in climate change adaptation policy • 2.1 The most vulnerable to climate change in Scotland are engaged, empowered and able to adapt to climate change • 2.2 Scotland's health and social care is ready and responding to changing demands as a result of the changing climate	Resilience of the population to changes in temperature (H)	Medium	Low
	Resilience of people to pathogens (H)	Low	Low
	Air quality (H)	Medium	Medium
	Emergency planning and response (BE)	High	Medium
3. Our inclusive and sustainable economy is flexible, adaptable and responsive to the changing climate • 3.1 Scotland's businesses based on natural resources are informed and adaptable to climate change • 3.2 Scotland's manufacturing, services and wider economy are informed and adaptable to climate change • 3.3 Scotland's economy is innovative and harnesses the opportunities created as a result of climate change	Agricultural productivity (NE)	Low	Low
	Commercial forestry (NE)	High	Medium
	Commercial fisheries and aquaculture (NE)	Low	Medium
	Extreme weather impacts on business (B)	Medium	Low
	Supply chain disruptions (B)	Low	Low
	Water demand by industry (B)	Medium	Medium
	Business opportunities from adaptation to climate change (B)	Low	Low
4. Our society's supporting systems are resilient to climate change	Energy generation, transmission and distribution (I)	Medium	Low

• 4.1 Scotland's reserved supporting systems are resilient to climate change • 4.2 Scotland's devolved supporting systems are resilient to climate change	Public water supply infrastructure (I)	Low	Medium
	Airports (I)	Low	Low
	Ports and ferries (I)	Low	Low
	Rail network (I)	High	Medium
	Road network (I)	Medium	Low
	Telecoms, digital and ICT infrastructure (I)	Low	Low
	Design and location of new infrastructure (I)	Medium	Low
	Infrastructure interdependencies (I)	Low	Low
5. Our natural environment is valued, enjoyed, protected and enhanced and has increased resilience to climate change • 5.1 Scotland's biodiversity, ecosystems and landscapes are adaptable to the changing climate • 5.2 Scotland's natural environment and its contribution to wider societal adaptation is enjoyed, valued and maintained	Farmland habitats and species (NE)	Low	Low
	Terrestrial habitats and species (NE)	Medium	Low
	Freshwater habitats and species (NE)	Low	Medium
	Water management (NE)	Medium	Medium
6. Our coastal and marine environment is valued, enjoyed, protected and enhanced and has increased resilience to climate change • 6.1 Scotland's coastal and marine biodiversity, ecosystems and landscapes are adaptable to the changing climate • 6.2 Scotland's marine and coastal environment and its contribution to wider societal adaptation is enjoyed, valued and maintained	Marine and coastal habitats and species (NE)	Medium	Medium
	Coastal erosion risk management (BE)	Low	Low
7. Our international networks are adaptable to climate change • 7.1 Scotland's international food supply networks are resilient to the effects of climate change. • 7.2 Scotland is active in international governance, helping to manage the potential international instability caused by climate change. • 7.3 Scotland has an internationally open and connected economy which is adaptable to the changing climate.	Supply chains disruptions (B)	Low	Low
	Business opportunities from adapting to climate change (B)	Low	Low

Notes: Letters in brackets denote the associated sectoral chapters for each priority area: BE = Built Environment, H = Health, NE = Natural Environment, B = Business, I = Infrastructure. Some priority areas appear more than once, mapped to different SCCAP2 outcomes

We score progress in addressing these risks and implementing adaptation actions within each priority area across two dimensions:

This assessment of progress looks for good quality plans in all priority areas.

- **Planning for a changing climate:** Good adaptation requires that a changing climate is integrated into relevant strategies and plans right across the economy. We have identified several features of good adaptation planning and assess relevant policies against them. We assess each of these sequentially to determine the quality of adaptation planning in each area. These include:
  - Adaptation actions in plans: Plans should contain relevant adaptation actions implemented at sufficient scale to address the climate risks.
  - 'SMART' objectives: Good planning will have clearly stated and appropriate adaption-relevant outcomes with a clear link to how implementation of the identified adaptation actions would lead to their achievement. These objectives should be specific, measurable, attainable, relevant and time bound.
  - Monitoring and evaluation: Effective and well-resourced monitoring and evaluation systems are needed to track the effectiveness of adaptation implementation and whether they are having the expected effect on helping to limit risks.
  - Considering warming levels: Adaptation planning should also consider the range of different climate futures that might be experienced depending on the success of global efforts to reduce emissions and the response of the climate to greenhouse gas emissions. A range of global warming levels from 2 - 4°C above pre-industrial levels by 2100, as used in the CCRA, is representative of the spread of possible climate futures relevant for adaptation planning.

The assessment methodology looks for relevant data on changes to vulnerability, exposure or climate impacts.

- **Progress in managing risk:** We assess relevant indicators of vulnerability, exposure, adaptation implementation, and climate change impacts to assess how risk is changing, and whether goals remain on track to be met. For this step, we also consider how the actions set out in the SCCAP, and other relevant programmes are addressing risk.

Each adaptation priority area is given a score of high, medium or low for planning for a changing climate and progress in managing risks. Specific criteria for scoring in each dimension are presented in Table 1.2. Throughout this assessment we have endeavoured to implement this scoring framework consistently. However, for many priority areas a lack of monitoring (Box 1.2) or lack of relevant indicators regarding risk management, together with multiple relevant strategies or plans, means that some level of expert judgement is required to score priority areas on this scale.

Each priority area is given a score for planning and a score for risk management.

Box 1.2
Monitoring and evaluation in the second SCCAP

The SCCAP does not currently contain an operational monitoring and evaluation (M&E) framework. Implementation of the framework proposed within the SCCAP, including process, sub-outcome and outcome indicators was paused during the COVID-19 pandemic and has not yet been resumed. Without an effective, operationalised M&E framework it is very difficult to track progress towards adaptation objectives.

In the absence of this M&E framework the Scottish Government have produced two progress reports since the second SCCAP was published. These progress reports present examples of progress across the different plans and policies outlined in the SCCAP, but do not provide an overview of whether plans and policies in the SCCAP (or in other newer policy documents) have been implemented and do not provide a long-term alternative to an effective M&E framework.

The Committee urgently recommends that an M&E framework is developed and implemented for the SCCAP, including indicators which measure the effectiveness of adaptation actions where possible. A strong M&E framework has been developed for the Climate Change Plan for progress on reducing greenhouse gas emissions in Scotland, including outcome-level policy indicators and can serve as a template system for SCCAP2.

We provide detailed recommendations related to each adaptation priority to improve its score in future. These are provided at the beginning of each chapter in this report and are included within a dedicated annex to this report.

Table 1.2
Assessment framework for this report

Score	High	Medium	Low
Plan Score	**Good quality plan: Considers climate change, including a range of scenarios (adaptation planning for inevitable change i.e. a 2°C scenario, consideration of risks for a 4°C scenario)** **Sets out specific action – not just guidance** SMART – specific, measurable goals with timescales Has effective monitoring and evaluation built in Can see links from the plan down to the actions Plans up to date	**Medium quality plan:** **Considers climate change, though possibly vague on what scenarios are included Requires general action – not just guidance** Some aspects of being SMART Some monitoring and evaluation Some links to action	**Low quality plan:** **Minimal or no consideration of climate change** **No firm actions, not SMART** No monitoring and evaluation No firm link through to actions Plans not up to date
Risk Management Score	**Evidence that risk (vulnerability and exposure) is reducing at an appropriate rate, and/or is in line to meet goals** **Good evidence of impact of actions on risks**	**Mixed picture – some evidence of risk being managed, but other areas where progress is lacking** **Some evidence of impact of actions on risks**	**Evidence that risk is not reducing or is increasing, or lack of evidence to judge what is happening to risk** **No evidence that actions are having an impact on risk**

Notes: Bold criteria are considered as key to that score; other criteria are also assessed but are of lesser importance.

3. The societal context for adaptation action in Scotland

This section is structured in three parts:

a) The COVID-19 recovery in Scotland

b) Priorities for integrating adaptation as part of a resilient COVID-19 recovery

c) Understanding and awareness of climate risks

a) The COVID-19 recovery in Scotland

Sustaining effective adaption action to address climate risks requires adaptation to be integrated and aligned with wider Government and societal priorities. In Scotland, one of the major policy priorities is currently the recovery from the COVID-19 pandemic.

The Covid-19 pandemic has had a deep and wide-reaching impact across Scotland in the last two years.

The Scottish Government have identified four impacts of COVID-19 throughout the pandemic:[17]

- **Direct impact of COVID-19.** Since the start of the pandemic there have been over 1.4 million confirmed cases of COVID-19, and over 13,000 deaths in Scotland.[18]
- **Other health impacts.** The indirect impacts of the pandemic on health are wide-ranging and complex. Health and social care services have changed along with the way people use these services.[19]
- **Societal impacts.** There has been increased uptake of Scottish Welfare Fund crisis grants, reduced police recorded crime, and high levels of reported loneliness. School closures have affected children's education and wellbeing.[20]
- **Economic impacts.** Scotland's economy experienced a significant shock due to the concurrent impact of Covid restrictions and EU Exit. GDP in Scotland fell by a record amount in 2020, while Scotland's unemployment rate and benefit claimant count rose.[21] Economic impacts which have increased deprivation will also have impacted people's health.[22] In 2021 Quarter 3 (July-September), the level of GDP was 2.2% below the level in 2019 Quarter 4 (Oct-Dec), prior to the impacts of the coronavirus (COVID-19) pandemic.[23]

In the long-term, potentially longer-lasting societal changes triggered by the pandemic (e.g. more home-working) may be the most important consequence of COVID-19 for exposure and vulnerability to climate risks across Scotland. In the near-term, the effects on Scotland's economy and public spending priorities, together with the impact on Government and public agency delivery capacity in non-COVID related areas are likely to be most relevant to implementing adaptation action.

In some cases, adaptation action has also been affected by the Covid-19 pandemic.

The effects of the need for COVID-19 prioritisation in Government delivery capacity have already been felt in climate change adaptation over the course of the pandemic. For example, there is not yet a monitoring and evaluation framework in

place for the SCCAP, and publication of SEPA's flood risk management plans was delayed.

b) Priorities for integrating adaptation as part of a resilient COVID-19 recovery

In May 2020 the CCC wrote to the Cabinet Secretary for Environment, Climate Change and Land Reform to provide advice for a resilient green recovery from the COVID-19 crisis, outlining six principles:

1. Use climate investments to support the economic recovery and jobs
2. Lead a shift towards positive long-term behaviours
3. Tackle the wider 'resilience deficit' on climate change
4. Embed fairness as a core principle
5. Ensure the recovery does not 'lock-in' greenhouse gas emissions or increased climate risk
6. Strengthen incentives to reduce emissions when considering fiscal changes

The CCC previously provided advice for a resilient green recovery.

In the subsequent economic recovery plans and the Update to the Climate Change Plan (2020) published by the Scottish Government, much of this advice has been incorporated. In particular, the Committee welcomes the announcement of an additional £150 million for flood risk management over five years and £12 million for coastal change adaptation.

As the priorities of the COVID-19 recovery in Scotland shift in response to the evolving nature of the pandemic, the potential longer-term societal changes triggered by COVID-19 mean that tackling the challenges of a changing climate are increasingly important in the following areas:

- **Increasing the resilience of digital infrastructure to climate change risks.** The Economic Recovery Implementation Plan (2020) recognises the 'importance of the strength and resilience of Scotland's national digital and data infrastructure' which has been put into sharp focus during the pandemic as many people have moved to working from home. Our assessment finds that the Scottish Government's plans for digital infrastructure do not currently consider climate risks and data on the performance of digital infrastructure under weather-related disruption is not collected. This area of policy could be strengthened to support ongoing working from home as part of recovery efforts.

- **Ensuring home retrofitting also reduces overheating risks.** The Update to the Climate Change Plan (2020) announced increased commitments to heat and energy efficiency in buildings. The drive to retrofit homes is an opportunity to also address overheating risks which are expected to increase in the coming decades. Overheating in buildings can impact health, wellbeing and productivity, which may be increasingly important if increased levels of home working remain in the long-term. The Scottish Government should ensure homes are retrofitted to be truly fit for the future by assessing overheating risks in different building types and enabling adaptation measures, such as improved ventilation, shading and shutters, where required.

- **Investing in adaptation jobs and skills.** The Climate Emergency Skills Action Plan (2020) identifies changes needed in the skills system to prioritise and support green jobs as part of the recovery from Covid-19. This investment in green jobs and skills should also target climate adaptation jobs, which are only touched on briefly. For example, CCRA3 identified potential opportunities for increased tourism in the UK due to warmer summers which is augmented by an increased appreciation for nature tourism following the pandemic. There are also a range of nature-based jobs which will need to increase to meet adaptation objectives, such as jobs in peatland restoration, woodland restoration, natural flood management, urban green infrastructure and sustainable marine management. The Scottish Government should build a better understanding of the potential adaptation and resilience economy and invest in upskilling to support an increase in adaptation-related jobs.

- **Increasing the resilience of supply chains to global climate changes.** The Covid-19 pandemic has highlighted the importance of resilient supply chains in the face of global disruptions. While the Global Capital Investment Plan (2021) and the Scotland Vision for Trade (2021) both reference the challenges of the pandemic and include commitments to Net Zero, there is a missed opportunity to support businesses recovering from the pandemic to also make their supply chains more resilient to climate-related shocks. The Scottish Government should ensure supply chain risks from extreme weather are included in key economic development strategies as resilient supply chains underpin a strong economy.

c) Understanding and awareness of climate risks

Sustaining effective adaptation action at all levels is supported by public and business awareness of climate risks and the need for adaptation action.

Awareness and understanding of climate risks in Scotland has increased in recent years.

People are becoming more concerned about climate risks in the UK and Scotland.

- In 2020, a Climate Assembly was convened in order to understand public perception of how Scotland should tackle the climate emergency. The findings of the Assembly were laid before the Scottish parliament in June 2021. The main focus of this assembly was on how to reduce greenhouse gas emission in Scotland, but adaptation was also discussed.

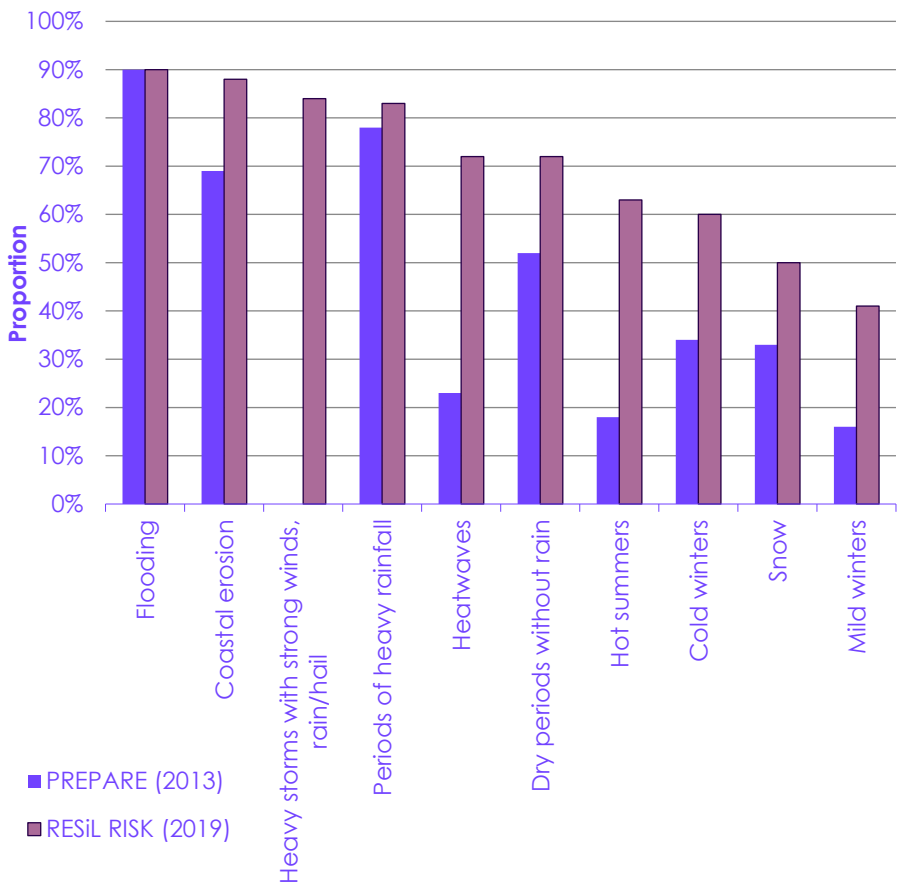
- Recent surveys have indicated that concern regarding climate risks in the UK (including Scotland) have risen over time (Figure 1.2).

- The Scottish Government has also supported increased awareness of climate risks across public and private sector organisations through Scotland's Adaptation Capability Framework (Box 1.3).

Public bodies report on their adaptation actions to the Scottish Government currently, but this information is not being analysed.

Public bodies currently have a duty to report annually on what actions they are taking on climate change, including for adaptation. This is a stronger requirement than anywhere else in the UK. These reports could provide a useful source of information on the understanding and awareness of climate risks across the public sector but the adaptation information in these is currently not being analysed by the Scottish Government. Regular assessment of these reports could provide useful insights into climate preparedness across the public sector and help avoid this reporting requirement being seen as burdensome and without purpose.

Figure 1.2 Proportion of respondents answering fairly or very serious to the question 'How serious of a problem do you think the following currently are for the UK?'



Source: Steentjes, K. et al (2020) *British public perceptions of climate risk, adaptation options and resilience (RESiL RISK): Topline findings of a GB survey conducted in October 2019.*

Box 1.3
Scotland's Adaptation Capability Framework

In 2019 Adaptation Scotland launched the Adaptation Capability Framework (ACF). This framework is aiming to support organisations across the public and private sector to adapt to climate change and factor it within their decision making. This framework identifies four adaptation 'capabilities':

- Organisational Culture and Assets
- Understanding the Challenge
- Planning & Implementation
- Working Together.

Multiple tasks are detailed for each capability and develop over four maturity stages: Starting, Intermediate, Advanced, and Mature. The ACF shifts away from typical risk-based guidance also recognising that effective leadership, governance arrangements, inclusive planning approaches and working beyond organisation and sectoral silos are of equal importance for successful adaptation.

Examples of organisations using the ACF include: Forestry and Land Scotland, which looks after Scotland's national forests and land and has been actively using Adaptation Scotland's Adaptation Capability Framework since 2019; Transport Scotland; Aberdeen City, Aberdeenshire, Glasgow, and Dundee councils; and Historic Environment Scotland.

Source: Adaptation Scotland (2022) *Public Sector.* https://www.adaptationscotland.org.uk/how-adapt/your-sector/public-sector

Endnotes

[1] Adaptation Scotland (2021) *Climate trends and projections* https://www.adaptationscotland.org.uk/why-adapt/climate-trends-and-projections

[2] Sniffer (2021) *Evidence for the third UK Climate Change Risk Assessment (CCRA3) Summary for Scotland.*

[3] Scottish Government (2020) *Sea level and tides*. Available at: http://marine.gov.scot/sma/assessment/sea-level-and-tides

[4] Sanchez-Romero, A. et al. (2014) *The signal of aerosol-induced changes in sunshine duration records: A review of the evidence*. J. Geophys. Res. Atmos., 119, 4657–4673; Christidis N. et al. (2016) Human Contribution to the Record Sunshine of Winter 2014/15 in the United Kingdom. Bulletin of the American Meteorological Society, 97, 12, S47-S50.

[5] Sniffer (2021) *Evidence for the third UK Climate Change Risk Assessment (CCRA3) Summary for Scotland.*

[6] Met Office (2019) *UKCP18 Factsheet: Derived projections.*

[7] Sniffer (2021) *Evidence for the third UK Climate Change Risk Assessment (CCRA3) Summary for Scotland.*

[8] CCC (2019) *Final assessment of Scotland's first Climate Change Adaptation Programme*.

[9] The Scottish Government (2018) *Climate Change Plan, Third Report on Proposals and Policies 2018-2032 (RPP3),* https://www.gov.scot/publications/scottish-governments-climate-change-plan-third-report-proposals-policies2018-9781788516488/

[10] CJC Consulting (2015) *The economic contribution of the forestry sector in Scotland,* https://scotland.forestry.gov.uk/images/corporate/pdf/economic-contribution-forestry-2015.pdf

[11] The UK Climate Risk Independent Assessment (CCRA3) Summary for Scotland, https://www.ukclimaterisk.org/independent-assessment-ccra3/national-summaries/

[12] The UK Climate Risk Independent Assessment (CCRA3) Summary for Scotland, https://www.ukclimaterisk.org/independent-assessment-ccra3/national-summaries/

[13] Watkiss, P., Cimato, F., Hunt, A. (2021) Monetary Valuation of Risks and Opportunities in CCRA3. Supplementary Report for UK Climate Change Risk Assessment 3, prepared for the Climate Change Committee, London.

[14] CCC (2019) *Final assessment of Scotland's first Climate Change Adaptation Programme*.

[15] CCC (2021) *Progress reducing emissions in Scotland – 2021 Report to Parliament.*

[16] CCC (2021) *Progress in adapting to a changing climate.*

[17] Scottish Government, Four Harms Dashboard, https://data.gov.scot/coronavirus-covid-19/index.html

[18] Scottish Government (figures correct at 23/02/2022), Coronavirus (COVID-19): daily data for Scotland, https://www.gov.scot/publications/coronavirus-covid-19-daily-data-for-scotland/

[19] Public Health Scotland, COVID-19 wider impacts on the health care system https://scotland.shinyapps.io/phs-covid-wider-impact/

[20] Public Health Information for Scotland (2021), *COVID-19 Wider Impacts*, https://www.scotpho.org.uk/comparative-health/coronavirus-covid-19/covid-19-wider-impacts/

[21] Scottish Government (2021) *Covid Recovery Strategy: for a fairer future,* https://www.gov.scot/publications/covid-recovery-strategy-fairer-future/pages/2/; Scottish Government (2021) Four Harms Dashboard, https://data.gov.scot/coronavirus-covid-19/detail.html#4_economic_impacts

[22] Public Health Information for Scotland (September 2021) *COVID-19 Wider Impacts,* https://www.scotpho.org.uk/comparative-health/coronavirus-covid-19/covid-19-wider-impacts/

[23] Scottish Government (February, 2022) *GDP Quarterly National Accounts: 2021 Quarter 3 (July to September)*

Chapter 2

Natural Environment

Table 2
Progress summary – Natural Environment

Adaptation Priority	Plan Score	Risk Management Score
Farmland Habitats and Species	Low	Low
Terrestrial Habitats and Species	Medium	Low
Freshwater Habitats and Species	Low	Medium
Marine and Coastal Habitats and Species	Medium	Medium
Commercial Forestry	High	Medium
Agricultural Productivity	Low	Low
Commercial Fisheries and Aquaculture	Low	Low
Water Management	Medium	Medium

This chapter assess progressing in adapting to climate risks in the natural environment.

This chapter considers progress in adapting the natural environment to climate change, including both natural capital assets, and the ecosystem services they provide. The natural environment will be affected both by extreme weather and by slower onset changes in the climate, as average temperature and rainfall patterns change. The natural environment underpins human wellbeing and economic activity from goods such as food and timber to services such as carbon, water, nutrient cycles and pollination.

There are both risks to and opportunities for the natural environment from the effects of a changing climate, including relating to Net Zero. For example, peatlands can sequester carbon and help ensure water flow and quality if they are in good condition, but they are at risk of degradation, leading to greater carbon emissions, as the climate changes.

The key points from the assessment are:

- **There has been good progress in climate adaptation for commercial forestry due to a cohesive strategy and implementation plan** from Scottish Forestry and an adaptation action plan and accompanying staff guidance from Forestry and Land Scotland. Certified woodland areas have also increased, so more areas are now being managed sustainably.

- **Farmland habitats and species has been flagged as high concern due to a lack of adaptation plans and insufficient data** to understand how the risk is being managed, despite farmland making up 73% of land area in Scotland. The agriculture sector still lacks a coherent strategy to ensure it remains productive under future climate change.

- **The Scottish Government has made insufficient progress against its targets for terrestrial habitats and species**, for example for peatland restoration and reducing habitat loss.

- **The latest River Basin Management plans from the Scottish Environmental Protection Agency (SEPA) do not include consideration of future climate change**, despite the potential for climate change to affect freshwater habitats and species, commercial fisheries and aquaculture yields.

- **There have been significant increases in marine protected areas** around Scotland, but a mixed picture for the condition of marine mammals, birds, and fish.

Recommendations for improving the quality of adaptation planning and the ability to manage the risks are set out in Table 2.1.

Table 2.1
Natural Environment recommendations

Priority Area	Recommendations
Farmland Habitats and Species	An overarching 'wrapper strategy' would be useful to clearly outline the relationships and interactions between the multiple action plans and strategies both published and in development for the farmland habitats and the broader environment. Plans underway to replace existing agricultural land management policy must include better recognition of the need to protect and enhance the condition of farmland habitats and species The new biodiversity strategy should take into account and support farmland habitats and species, as well as other terrestrial habitats and species.
Terrestrial Habitats and Species	A monitoring framework should be developed for the National Peatland Plan. It should include regular monitoring and reporting on peatland condition, supported by a research programme to develop suitable indicators. The new biodiversity strategy should respond to climate risks to habitats and species; include clear targets and effective monitoring and evaluation; and target climate-sensitive and invasive species. The Scottish Government should identify barriers to achieving current peatland targets consider financial incentives or facilitating private investment in peatland restoration
Freshwater Habitats and Species	Include adaptation to changing climatic conditions as an integral part of the next River Basin Management Plan, ensuring that climate change projections of temperature, precipitation and sea level rise are considered.
Marine and Coastal Habitats and Species	The Marine Plan (2015) should be updated to reflect the latest evidence in the Independent Assessment of UK Climate Risk (CCRA3) and UKCP18 climate projections. Scottish Government should implement the recommendations of the Environment, Climate Change and Land Reform Committee, in particular to: • Publish a vision statement on regional marine planning identifying priority regions for future rollout • Publish new national guidance for regional marine planning. This should include how climate change adaptation can be incorporated into regional marine plans
Commercial Forestry	Scottish Forestry should include indicators on pests and pathogens as part of monitoring the Forest Strategy Implementation Plan and report on them regularly.

Agricultural Productivity	The Scottish Government should develop a long-term strategy to replace existing arrangements aligned to the EU Common Agricultural Policy, which prepare the agricultural sector in Scotland for the range of risks and opportunities from climate change. Actions should respond to risks from flooding, more intense rainfall and higher temperatures, and improve the technological capability of the sector to respond to threats such as changing pest and disease risks. A structured approach to incorporating the potential impacts from a changing climate into long-term land use planning is essential for land managers to successfully adapt to climate change. The Scottish Government should help increase awareness of the potential climate risks to agricultural production, through owning and supplying the required information, and providing a mechanism for landowners to use it.
Commercial Fisheries and Aquaculture	The Future Fisheries Management Strategy, The Finfish Aquaculture Sector Plan and the Farmed Fish Health Framework should be updated with specific adaptation actions, SMART objectives and appropriate monitoring and evaluation to support commercial fisheries and aquaculture to adapt to a changing climate and ocean acidification.

There are eight priority areas assessed in this chapter:

1. Farmland habitats and species
2. Terrestrial habitats and species
3. Freshwater habitats and species
4. Marine and coastal habitats and species
5. Commercial forestry
6. Agricultural productivity
7. Commercial fisheries and aquaculture
8. Water management

1. Farmland habitats and species

Progress summary – Farmland habitats and species

Plan score: low

- Government policy in relation to farmland habitats and species will remain aligned to the EU Common Agricultural Policy (CAP) in the short term. A replacement strategy for agriculture is currently in development, although it is not clear at this stage when it will be published.
- There are a range of plans and strategies in place, and in development, that will individually support the condition of farmland habitats and species, however, an overarching strategy is needed that clearly outlines the relationships and interactions between the multiple initiatives.
- Some progress has been made in relation to efforts to support soil health, with a range of policies and legislation that protect some aspects of soil and influences how these are managed.

Risk management score: low

- There remains limited data available to confidently assess the vulnerability of farmland habitats and species to climate impacts, although work to develop a range of soil indicators is underway.
- Species indicators on farmland suggest a net positive increase over the long-term, although there is significant variation amongst individual species.

Relevant risks from CCRA3:

- N1 Risks to terrestrial species and habitats from changing climatic conditions and extreme events, including temperature change, water scarcity, wildfire, flooding, wind, and altered hydrology
- N2 Risks to terrestrial species and habitats from pests, pathogens and invasive species
- N4 Risks to soils from changing climatic conditions, including seasonal aridity and wetness
- N6 Risks to and opportunities for agricultural and forestry productivity from extreme events and changing climatic conditions (including temperature change, water scarcity, wildfire, flooding, coastal erosion, wind)
- N7 Risks to agriculture from pests, pathogens, and invasive non-native species

More information on the related risks can be found in CCRA agriculture sector briefing and the CCRA technical report chapter 3.

a) Introduction

Agricultural land in Scotland covers 5.6 million hectares - approximately 73% of Scotland's total land area.[1] The condition of farmland and croftland* habitats can be used as a proxy to indicate their vulnerability to climate change, since better condition can be interpreted as higher resilience. At present, however, 85% of the agricultural land is currently designated as Less Favoured Area.†

* A croft is a type of small agricultural land holding, normally held in tenancy, which is unique to Scotland, with its own specific legislation.

† Originally a term introduced by EU policy, Less Favoured Areas are areas which are more environmentally challenging for farming such as lack of water, short crop season or that are mountainous or hilly.

Farmland habitats and species can be affected by changing rainfall patterns, which may lead to periods of water scarcity or flooding; increased average temperature and temperature extremes (including possibly increased wildfire risk); and potential increases in the number of pests, pathogens and invasive non-native species (INNS) due to warmer winters. Farmland areas are also exposed to significant other pressures from intensive agricultural practices. Where these activities have degraded the quality of this land, that land is likely to be highly vulnerable to the effects of climate change. This priority area has important links to Scotland's greenhouse gas emissions reduction targets as the condition of woodlands and peatlands is indicative of their carbon storage potential. The distinct land management practices applied to farmland means that it is treated separately to the terrestrial habitats and species priority in this report.

Policy for farmlands is currently still aligned to the EU Common Agricultural Policy.

Most policy relating to this priority area is devolved to the Scottish Government.* Current arrangements, aligned to the EU Common Agricultural Policy (CAP), are continuing in the short term in lieu of further policy development for a replacement strategy for agriculture. The existing CAP architecture and rules have been transferred into Scottish law, via the EU (Withdrawal) Act 2018 and the Direct Payments to Farmers (Legislative Continuity) Act 2020. The Agriculture (Retained EU Law and Data) (Scotland) Act 2020 gives Scottish Ministers the opportunity to modify that retained EU law.[2] The Scottish Government has also announced that a Natural Environment Bill will be introduced in the current Parliamentary term which will provide statutory targets for biodiversity.

b) Planning score

The level of adaptation planning is scored as **low.**† There is currently no overarching adaptation plan, or consideration within existing plans, that addresses the range of risks to farmland habitats and species in Scotland from climate change. However, some progress has been made in improving the management of soils.

- **Adaptation actions in plans.**
  - The Environment Strategy for Scotland (2020) and the Land Use Strategy do not include outcomes and a supporting set of actions specific to building the resilience of farmland habitats to future climate change.‡ Scotland's Climate Change Plan 2018-2032 includes actions in relation to woodland creation on farmland, which, if done correctly could support resilience climate change (e.g. through increased biodiversity). However, there is insufficient consideration of the range of actions required to support farmland habitats and species in Scotland to adapt to the current and future impacts of climate change, including temperature change, water scarcity, wildfire,

* While most agriculture and environment policy relating to this priority is devolved to Scottish Government, some parts of the UK Agriculture Act 2020 and UK Environment Act 2021 apply to Scotland and some other policies of relevance for agriculture are reserved, for example the taxation of red diesel. A breakdown of the parts the Agriculture Act that apply to Scotland can be found here: https://digitalpublications.parliament.scot/ResearchBriefings/Report/2020/3/27/Revised-UK-Agriculture-Bill-2020. A breakdown of the provisions of the Environment Act that apply to Scotland can be found here: https://digitalpublications.parliament.scot/ResearchBriefings/Report/2020/5/28/The-UK-Environment-Bill

† Relevant strategies and policies relating to farmland habitats and species are: The Third Land Use Strategy (2016); the Environment Strategy for Scotland (2020); Scotland's Climate Change Plan; and the Fourth National Planning Framework (NPF4) which is currently under development. A new biodiversity strategy, with associated targets, is expected in October 2022.

‡ The Environment Strategy for Scotland (2020) provides an overarching framework to bring together the range of strategies that aim protect and restore Scotland's natural environment (see also *Terrestrial Habitats and Species*) The Land Use Strategy sets the policy direction for greater integration of land use and the delivery of multiple benefits from land in Scotland. The Strategy covers the 2021-2026 period and sets out the Scottish Government's vision, objectives and policies to achieve sustainable land use.

flooding, and outbreaks of pests, pathogens and invasive non-native species, as outlined in CCRA3.

A new biodiversity strategy is being developed, to be published later this year.

– The Scottish Biodiversity Strategy and Route Map to 2020 provided a framework for setting goals, providing guidance and monitoring the protection of habitat species. After delays in the agreement of a new global biodiversity framework, the Scottish Government published a Statement of Intent on biodiversity in December 2020 which continued the principles and associated projects in the Route Map to 2020 as well as committing to publish a new, high-level policy-focused Scottish Biodiversity Strategy in October 2022. At the time of this assessment, work on this was at an early stage. It is unclear how targets under the successor biodiversity strategy will support farmland habitats and species.

SEPA has developed plans for agriculture sub-sectors which provide guidance on soils

– Soil health features heavily in the draft National Planning Framework (NPF4) as part of nature-based solutions. However, the primary focus is on activities to achieve Net Zero, with limited direct consideration of climate adaptation. For marginal agricultural lands, a framework to assess adaptation options has recently been developed to highlight changing synergies and trade-offs.[3] The Scottish Environmental Protection Agency (SEPA) has been developing 'Delivering One Planet Prosperity' sector plans. Under the initiative, plans have been developed, or are in development, for a number of agriculture sub-sectors that provide guidance on soils and off-site impacts on water quality across a range of activities. The Soil and Nutrient Network and the Farm Advisory Service Strategy is an existing initiative that can facilitate delivery of progress on requirements for sustainable soils. The 'Farming for a Better Climate' initiative also has options for the agricultural sector that aim to link enhanced farm productivity with improved soil protection and associated reduction of GHG emissions.

c) Risk management

The management of climate risks to farmland habitats and species is scored as **low**. As noted above, data on farmland habitat condition and species abundance can be used as proxy indicators of resilience to climate change. However, there is currently limited data available to confidently assess the vulnerability of farmland habitats and species and soils in Scotland to current and future climate change impacts.

There is not enough data to assess the vulnerability of farmland habitats and species.

- **Species indicators on farmland in Scotland show an increase over the long term.** Habitats need to be in good condition, bigger, and more connected in order to have a greater chance of allowing the species they support to adapt naturally as the climate changes. Reliable farmland biodiversity indicators are not available for all species, but the abundance of species groups such as birds provide a good indication of the overall state of the farmed environment, which is an indicator of the expected resilience to future climate changes. The farmland bird index increased steadily up to the late-2000s, peaking at 24% above the 1994 index value. In 2019, it was 14% higher than in 1994. However, the scale of such population changes varies between species.

- **Work has been undertaken that will support the development of a range of soil indicators.** A report by ClimateXChange identified 13 potential indicators that could be used as a framework to guide regular resampling to update long-term national datasets. The study also highlighted a critical knowledge gap regarding the dependencies and interdependencies of those indicators, especially for interactions between soil biological diversity and function.[4] Further research was carried out to build on the findings of the previous 13 indicators and consider their strategic relevance in the context of existing main types of land use in Scotland, (arable, peatland, grassland etc).[5] The study found seven indicators were extremely important, although the issue of dependency between indicators remains complex.

- **Data on the proportion of high nature value farmland is no longer collected.** High Nature Value (HNV) farmland is where traditional farming and crofting methods in Scotland – primarily livestock production – aim to create a rich diversity of wildlife habitats. Enhancing biodiversity can support the adaptive capacity of an ecosystem to sustain itself over long periods of time and to withstand disruption and stresses from climate change. HNV farmland is estimated to account for 44% of the Utilised Agricultural Area (UAA), although data for this was last collected for the 2014 period.[6] There is currently no government target for HNV farmland.

2. Terrestrial habitats and species

Progress summary – Terrestrial habitats and species

Plan score: Medium

- There are plans in place for peatland restoration and woodland management which, if properly implemented, will help build resilience of terrestrial habitats. The Environment Strategy and the Land Use Strategy do not include specific adaptation actions.

Risk management score: Low

- Peatland restoration, woodland condition and overall habitat loss reduction targets have not been met. Actions to conserve priority species have been completed but terrestrial breeding bird populations show mixed progress.

Relevant risks from CCRA3:

- N1 Risks to terrestrial species and habitats from changing climatic conditions and extreme events, including temperature change, water scarcity, wildfire, flooding, wind, and altered hydrology
- N2 Risks to terrestrial species and habitats from pests, pathogens and invasive species
- N3 Opportunities from new species colonisations in terrestrial habitats
- N4 Risk to soils from changing climatic conditions, including seasonal aridity and wetness.
- N18 Risks and opportunities from climate change to landscape character

More information on the related risks can be found in CCRA technical report chapter 3, Scotland National Summary, Terrestrial Biodiversity Briefing.

a) Introduction

This adaptation priority covers terrestrial habitats and the species they contain around Scotland, excluding farmlands. Terrestrial habitats include woodlands, mountains, heaths and bogs, as defined by NatureScot.[7]

There are links to Scotland's greenhouse gas emissions reduction targets as woodlands and peatlands will store less carbon if they are not in good condition.

Terrestrial ecosystems are affected by changing rainfall patterns, leading to periods of water scarcity or flooding (e.g. in woodlands, future droughts may cause crown dieback which can lead to tree death); increasing extreme heat and wildfire risk (which could create risks of local extinction for specific species); and possible increases in the number of pests, pathogens and invasive non-native species (INNS) due to warmer winters. Terrestrial biodiversity contributes to Scotland's landscape character so changes in biodiversity may have landscape wide impacts. This priority area has important links to Scotland's greenhouse gas emissions reduction targets as the condition of woodlands and peatlands is indicative of their carbon storage potential. Actions to increase carbon storage in the landscape (e.g. afforestation) need to be evaluated for their impacts on biodiversity and adaptation.

The impacts of climate change on farmland and croft land areas are covered in the priority area: Farmland Habitats and Species.

Trees are considered in terms of woodlands here, but provisioning services* of trees are discussed in Commercial Forestry.

Relevant policy in this priority area is devolved to the Scottish Government. The Scottish Government has announced that a Natural Environment Bill will be introduced in the current Parliamentary term which will provide statutory targets for biodiversity.

b) Planning score

The level of adaptation planning is scored as **medium**.† There are plans in place for woodland management and peatland restoration with some SMART objectives. The Environment Strategy and Scottish Forestry Strategy Implementation Plan have accompanying monitoring frameworks, although this assessment was completed before the first reporting period for the Scottish Forestry Strategy.

- **Adaptation actions in plans.**

The Land Use Strategy does not include any new commitments or actions.

  – Strategies. The Environment Strategy for Scotland (2020) is a high-level framework on the environment, which includes an outcome on tackling the climate emergency, although it has a greater focus on mitigation than adaptation. There is also an outcome on protecting and restoring Scotland's biodiversity but it does not link this explicitly with increased resilience to climate change impacts. The strategy does not include specific actions. The Scottish Forestry Strategy 2019-2029 includes a good discussion on adaptation and climate impacts on forests and woodlands. The Land Use Strategy 2021-2026 is a high-level strategy setting out the Scottish Government's vision, objectives and policies to achieve sustainable land use, but with no new commitments or actions included. The Scottish Biodiversity Strategy and Route Map to 2020 provided a framework for setting goals, providing guidance and monitoring the protection of habitat species. After delays in the agreement of a new global biodiversity framework, the Scottish Government published a Statement of Intent on biodiversity in December 2020 which continued the principles and associated projects in the Route Map to 2020 as well as committing to publish a new, high-level policy-focused Scottish Biodiversity Strategy in October 2022. Work on this was at the early stages at the time of this assessment.

  – Implementation plans. The Scotland Forestry Strategy Implementation Plan 2020-2022 contains a section on increasing adaptability and resilience of forests and woodlands but the main adaptation action is to develop a programme of actions to improve resilience to climate change in Scotland's national forests which Forestry and Land Scotland (FLS) have completed. The first National Peatland Plan was published in 2015 and a new Peatland Programme for Scotland was established in 2021. The peatland programme will develop and deliver policies which protect peatlands, limiting negative impacts from extraction and development; restore degraded peatlands; and

* Provisioning services include the products that are obtained from ecosystems, such as: food, fibre, bioenergy, genetic resources, pharmaceuticals, water, and building materials such as timber.

† Relevant strategies and policies relating to terrestrial habitats and species are: the Environment Strategy for Scotland (2020); the Scottish Forestry Strategy 2019-2029 and the Forestry Strategy Implementation Plan 2020-2022; The Land Use Strategy 2021-2026; the Scottish Biodiversity Strategy and Route Map to 2020; the National Peatland Plan (2015); and the National Planning Framework.

manage peatlands holistically and sustainably, within the context of a changing climate.*

The draft National Planning Framework includes policies on peatlands and soil health but with a focus on achieving Net Zero.

– Planning system. The draft National Planning Framework (NPF4) includes policies to address the 'Nature crisis', which aims to ensure development plans facilitate biodiversity enhancement, nature recovery and nature restoration; and that any potential adverse impacts of development on biodiversity are minimised. Soil health and peatlands feature heavily as part of nature-based solutions. However, the primary focus is on activities to achieve Net Zero, with limited direct consideration of climate adaptation.

- **SMART objectives.** The Environment Strategy includes adaptation-relevant outcomes but not SMART objectives. The Scotland Forestry Strategy Implementation Plan 2020-2022 includes one main action related to adaptation which is specific, measurable, achievable, relevant and time-bound (to develop a programme of actions to improve the resilience of Scotland's national forests and land to climate change). The National Peatland Plan includes a measurable and time-bound objective of seeing peatland in a healthy state (a key adaptation-relevant outcome) and regarded as resilient by 2030. It also identifies 600,000 hectares of restorable peatland.

The monitoring framework for the Environment Strategy includes some useful indicators for measuring progress on adaptation.

- **Monitoring and evaluation.** An initial monitoring framework for the Environment Strategy was published in 2021 providing indicators against each outcome in the strategy. Most of the indicators are not directly relevant for adaptation but the framework commits to developing a composite biodiversity indicator and a soil health indicator to report on annually, which will be informative of adaptation progress. The Scotland Forestry Strategy Implementation Plan 2020-2022 also includes indicators for monitoring. The most relevant of these for adaptation are the woodland ecological score; the condition of protected forest and woodland sites; the index of abundance for Scottish Terrestrial Breeding Birds; and the area of forests and woodland covered by management plans. Scottish Ministers are required to report on The Forestry Strategy every three years, with the end of the first reporting period in March 2022. The finalised and approved National Planning Framework 4 (NPF4) will be accompanied by a monitoring programme, but this has not been developed yet. The National Peatland Plan mentions the importance of monitoring but does not yet include a monitoring framework.

- **Multiple climate scenarios.** None of the relevant plans in this area consider multiple climate scenarios.

c) Risk management score

The management of climate risks to terrestrial habitats and species is scored as **low**. Peatland, woodland and overall habitat targets have not been met. Actions to conserve priority species have been implemented and species trends for terrestrial breeding birds show mixed progress.

* The 2021/2022 Programme for Government announced £500 million to be invested in the natural economy over the course of this Parliament, including £250 million for the restoration of peatlands.

- **Peatland area restoration targets have been missed.** SCCAP2 included a target of 20,000 hectares per year of peatland restoration from 2019 but only around 6,000 ha of peatland have been restored annually from 2018-2020.[8]

- **Native woodland in good condition has reduced**. NatureScot reported in their third report on the Biodiversity Route Map that the percentage of woodland features in favourable or recovering condition dropped 5.6% in April 2019 to 62.5% from 68.1% in 2017.[9]

The condition of protected sites has decreased in the last five years.

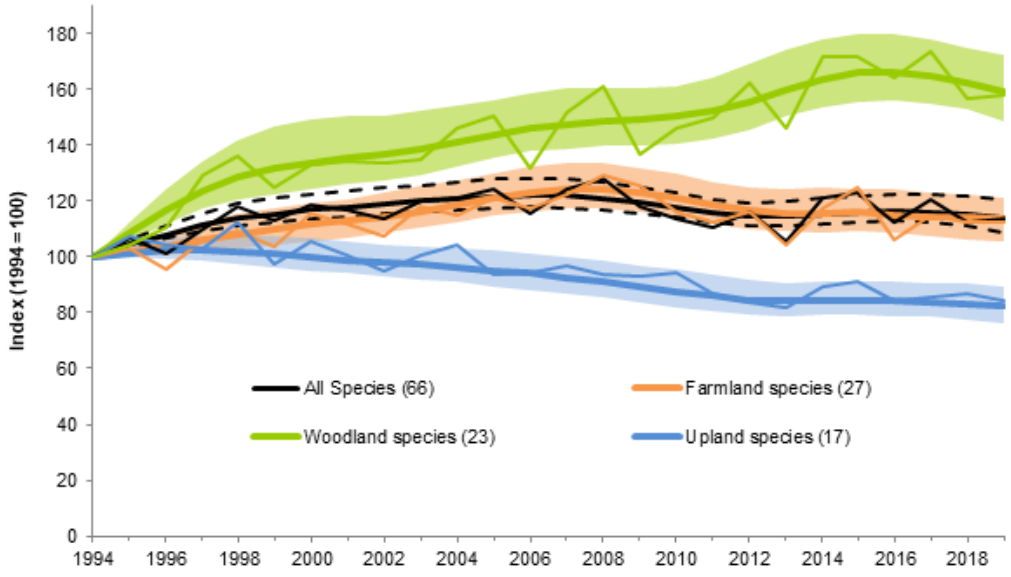
- **Protected land and freshwater areas have increased but overall habitat loss reduction targets have not been met.** In 2021, Scotland reported that it had made insufficient progress towards the Aichi target of habitat loss halved or reduced by 2020. NatureScot also reported that Scotland had made insufficient progress overall against targets for increasing and improving protected areas. While targets for bringing land and freshwater under site protection have been exceeded (23% of terrestrial and inland water areas, compared to a target of 17%), the condition of protected sites has decreased. Protected natural sites in favourable condition peaked at 80.4% in 2016 (from a baseline of 76% in 2007) and has since decreased to 78.9% in 2021, compared to a target of 80%.[10]

- **Actions to conserve priority species are mostly on track.** NatureScot reported in their third report on the Biodiversity Route Map that good progress had been made on delivering focused action for priority species in Scotland. Five actions under this priority project had been achieved, nine were on track to be delivered by 2020 and five had insufficient progress. Example actions which have been achieved are completing a freshwater pearl mussel conservation project in 2017; publishing and implementing a pollinator strategy for Scotland; and publishing conservation measures for Scottish Biodiversity List species. Example actions which have seen insufficient progress are restoring populations of curlew; and restoring populations of Corncrake.[11]

Reliable biodiversity indicators are not available for all species, but the abundance of species groups such as birds provide a good indication of the overall state of terrestrial habitats.

- **Terrestrial breeding bird populations show mixed progress.** Since 1994, the woodland bird index and farmland bird index have increased overall (59% and 14% above 1994 level respectively), while the upland bird index has decreased by 18%, as shown in Figure 2.1. Reliable biodiversity indicators are not available for all species, but the abundance of species groups such as birds provide a good indication of the overall state of terrestrial habitats, which is an indicator of the expected resilience to future climate changes. There is considerable evidence of the current effects of climate change, for example, the decline of some upland birds such as curlew and golden plover due to dryer soils affecting food supplies in their breeding grounds.

Figure 2.1 Index of abundance for Scottish Terrestrial Breeding Birds, 1994 to 2019



Source: NatureScot (2020) *Official Statistics – Terrestrial Breeding Birds 1994-2019.*
Notes: The thick and thin lines are smoothed and unsmoothed trends, respectively. Dashed lines and shaded areas indicate 95% confidence intervals.

- **Abundance data for bats and butterflies do not indicate a clear trend.** Population surveys for bats[12] and butterflies[13] in Scotland are available but both showed significant variation at the inter-species level, suggesting current actions have had a mixed impact on bat and butterfly population levels.

3. Freshwater habitats and species

Progress summary – Freshwater habitats and species
Plan score: Low • The River Basin Management Plan for Scotland does not include any specific actions on adaptation or clear consideration of changing climatic conditions. **Risk management score: Medium** • The condition of freshwater environments has improved marginally since 2016 and long-term trend for condition of natural features are stable.
Relevant risks from CCRA3: • N10 Risks to aquifers and agricultural land from sea level rise, saltwater intrusion • N11 Risks to freshwater species and habitats from changing climatic conditions and extreme events, including higher water temperatures, flooding, water scarcity and phenological shifts. • N12 Risks to freshwater species and habitats from pests, pathogens and invasive species • N13 Opportunities to freshwater species and habitats from new species colonisations • N18 Risks and opportunities from climate change to landscape character More information on the related risks can be found in CCRA technical report chapter 3, Scotland National Summary, Freshwater Habitats Briefing.

a) Introduction

This adaptation priority covers the impacts of climate change on freshwater habitats and the species they contain, including rivers, streams, canals and lochs. Freshwater habitats can be impacted by warmer water temperatures, extreme events, flooding and water scarcity. For example, the timing of salmon migration in rivers has been found to be correlated with freshwater temperatures. Freshwater species can also be affected by invasive non-native species (INNS) as a result of climate change.

The impacts of climate change on commercial fish and aquaculture are not covered here but are detailed in the priority area Commercial Fisheries and Aquaculture.

Relevant policy in this priority area is devolved to the Scottish Government.

b) Planning score

The level of adaptation planning is scored as **low.**[*] There are no specific adaptation actions included in the River Basin Management Plan for Scotland and no explicit consideration of increasing river water temperature.

- **Adaptation actions in plans.** Climate change is referenced in the River Basin Management Plan for Scotland (2021-2027) but there are no specific adaptation actions included in the plan. According to SEPA, at present only current risks from water shortages and higher water temperatures are taken into consideration when developing actions, although this is not evident in the plans. Future risks are not considered. While the plans set out a range of actions allocated by authorities responsible in Scotland, they lack specific adaptation activities to support management in a changing climate.

The latest River Basin Management Plan does not include specific adaptation actions.

SCCAP2 included a research project titled 'River Temperatures are Rising' which was completed at the time of publishing SCCAP2. It is unclear whether this research has been used to inform the River Basin Management Plan for Scotland.

c) Risk management score

The management of climate risks to freshwater habitats and species is scored as **medium**. The overall condition of freshwater has improved and long-term trends for condition of natural features are stable.

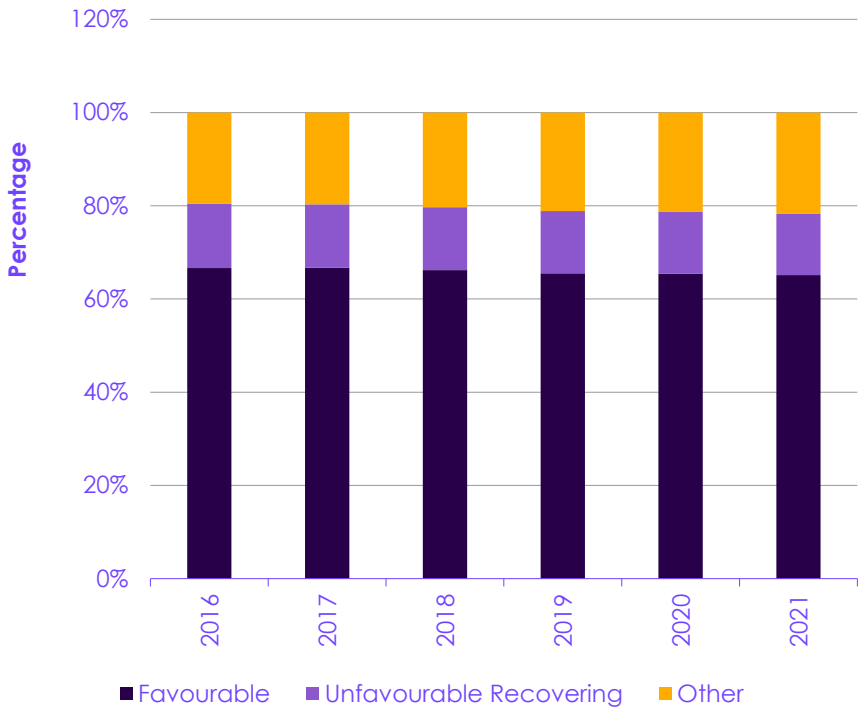
- **Overall condition of the water environment has improved slightly.** In the River Basin Management Plan for Scotland, SEPA report that in 2019 66% of the water environment was in good condition or better. This is a modest improvement of 3% since the previous River Basin Management Plan was published in 2016.

- **Natural Features in favourable condition has decreased recently.** NatureScot collect and publish data annually on the proportion of natural features on protected nature sites which are in satisfactory condition or are recovering (see Figure 2.2). Protected natural sites in favourable condition peaked at 80.4% in 2016 (from a baseline of 76% in 2007) and has since decreased to 78.3%[†] in 2021.

[*] The main plan relating to freshwater habitats and species is the River Basin Management Plan for Scotland (2021-2027), which was published at the end of 2021.

[†] The proportion of natural features in favourable condition are defined as those in favourable condition and those which are unfavourable but recovering.

Figure 2.2 Proportion of Natural Features in Favourable Condition



Source: NatureScot (2021) *The Proportion of Scotland's Protected Sites in Favourable Condition.*
Notes: Unfavourable recovering SCM and unfavourable recovering due to management change have been combined from the original source.

- **The target for restoration of freshwaters is on track to be achieved.** In the last progress report on the Scottish Biodiversity Strategy Routemap to 2020 (for the years 2017-2019), under restoration of freshwaters, two actions were reported as achieved; two as on track; and one as insufficient progress. Overall, the target is on track to 'achieve agreed ecological water quality objectives under the Water Framework Directive of river and lake water bodies and to contribute to meeting conservation objectives through scoping improvements to physical modifications'. Insufficient progress was made on the physical restoration of 4 pilot catchments and this work has since been scaled back due to resource constraints within SEPA.

4. Marine and coastal habitats and species

Progress summary – Marine and coastal habitats and species
Plan score: Medium • The National Marine Plan (2015) includes climate change adaptation but is missing the latest evidence on UK climate projections and climate risks. Its objectives are not easily measurable or time-bound. No Regional Marine Plans have yet been adopted. **Risk management score: Medium** • Indicators for mammals, fish and birds show mixed results. The network of Marine Protected Areas has increased in size, beyond original targets. Fish size has shown a dramatic decline.
Relevant risks from CCRA3: • N14 Risks to marine species, habitats and fisheries from changing climatic conditions, including ocean acidification and higher water temperatures • N15 Opportunities to marine species, habitats and fisheries from changing climatic conditions • N16 Risks to marine species and habitats from pests, pathogens and invasive species • N17 Risks and opportunities to coastal species and habitats due to coastal flooding, erosion and climate factors More information on the related risks can be found in CCRA technical report chapter 3, Scotland National Summary, Marine and Coastal Environment Briefing.

a) Introduction

Marine habitats and species will be affected by warming waters and ocean acidification.

This adaptation priority covers all coastal and marine habitats and the species they contain around Scotland. Marine ecosystems are affected by warming waters, variations in salinity, deoxygenation, changes in stratification (mixing of shallow warmer and deeper cooler waters) and acidification. Coastal habitats occur at the boundary of terrestrial and marine environments and are affected by coastal erosion, flooding and the pollution and runoff activities on land. The latest Independent Assessment of UK Climate Risk (CCRA3) found multiple examples of impacts to Scotland's marine and coastal habitats already. For example, changes in ocean temperatures, circulation and salinity are very likely to be factors in the decline of Atlantic salmon. Projections estimate large declines for the extent of coralline algae (a red algae which plays an important role in the ecology of coral reefs) habitats due to acidification, ranging from 38% to 84% under a scenario consistent with global warming of 2°C and a scenario reaching and exceeding 4°C by 2100 respectively, up to 2050.[14]

The impacts of climate change on farmed species of fish and seafood are covered in the priority area Commercial Fisheries and Aquaculture.

Relevant policy in this priority area (marine and coastal policy) is largely devolved to the Scottish Government in relation to activities affecting the marine environment in Scotland's inshore waters.* UK Parliament legislates for Scotland's offshore waters, but certain matters in this area have been executively devolved.

* Scotland's inshore waters extend from the coast out to 12 nautical miles.

Marine planning matters in Scotland's inshore waters are governed by the Marine (Scotland) Act 2010 and in its offshore waters by the Marine and Coastal Access Act 2009.

b) Planning score

The level of adaptation planning is scored as **medium.**[*] A changing climate is considered throughout the National Marine Plan, but objectives are difficult to measure and do not include timeframes. More up to date climate risk evidence has been made available in the six years since the plan was published which could be included. The Environment, Climate Change and Land Reform Committee published a report on Regional Marine Plans in Scotland in December 2020 with several recommendations to improve development and implementation.

The National Marine Plan has not been updated for six years.

- **Adaptation actions in plans.** The National Marine Plan (2015) considers adaptation across objectives and sectors.

- **SMART objectives.** The National Marine Plan includes objectives across 11 marine sectors. These objectives are appropriately specific, achievable and relevant; however they are largely not measurable or time bound. It is therefore difficult to assess to what extent the plan has been successfully implemented.

- **Monitoring and evaluation.** The National Marine Plan has been reviewed every three years, in accordance with UK legislation. Scotland is the only UK nation without (or not yet committed to) a funded coastal monitoring strategy. The recent Dynamic Coastal National Overview recommended that monitoring of coastal change should be improved.

More up to date climate change projections are now available which could be included in a new National Marine Plan.

- **Multiple climate scenarios.** The National Marine Plan does not explicitly consider multiple climate scenarios. Its assessment of climate risks is based on the UK's first climate change risk assessment published in 2012, which uses UKCP09 climate change projections. There are now more up to date UKCP18 climate change projections available from the Met Office and the latest independent assessment of UK climate risk was published in 2021, with four different relevant risks for marine and coastal habitats and species. The National Marine Plan (2015) is likely to be missing consideration of some key climate risks as a result. The National Marine Plan Review 2021 found a 'clear need' to begin work to replace the existing National Marine Plan, since significant external developments have arisen since the original plan was adopted, including impacts from climate change. The Scottish Government are currently considering whether to update the National Marine Plan in response.

c) Risk management score

The management of climate risks to marine and coastal habitats and species is scored as **medium.**

[*] Relevant strategies and policies relating to marine and coastal habitats and species are: the National Marine Plan (2015); Regional Marine Plans and Shoreline Management Plans. In 2020, the Scotland Marine Assessment was completed, providing an overall assessment of Scotland's marine environment and in 2021, the Dynamic Coast National Overview was published, providing updated evidence on coastal erosion in Scotland. In 2020, one more regional marine planning partnership was established in Orkney, bringing the total to three. No statutory Regional Marine Plans have been published to date. In the 2020-2021 Programme for Government the Scottish Government committed to the development of a Blue Economy Action Plan which had not been published at the time of writing.

The area of marine environment covered by Marine Protected Areas has increased; there are mixed population indicators for marine mammals, birds and fish; but fish sizes have reduced significantly.

The Scottish Government has increase the areas of the marine environment which are protected and has a new target to designate 10% of Scottish seas as highly protected marine area.

- **Marine Protected Areas (MPAs) have increased significantly.** Geographical areas of the marine environment which are established and managed to achieve long-term nature conservation and sustainable use are referred to as Marine Protected Areas. By helping to protect the overall environmental quality of these environments this action can help support resilience to future climate changes. 16 new sites were added to the Scottish MPA network in December 2020 and one new urgent MPA was designated in March 2021 to protect flapper skate eggs (Figure 2.3), although a full assessment after 12 months is required to make the designation permanent. Scotland's MPA network now covers 37% of the Scottish marine environment[15], an increase from 22% in 2018[16] and already exceeding the draft Convention on Biodiversity targets of 30%[17], which are currently under negotiation. In the 2020-2021 Programme for Government, Scottish Government announced a new target to designate 10% of Scottish seas as highly protected marine areas (HPMAs)* by 2026 (subject to cooperation with UK Government).[18]

The Scotland Marine Assessment provided updated evidence of the state of Scotland's marine environment.

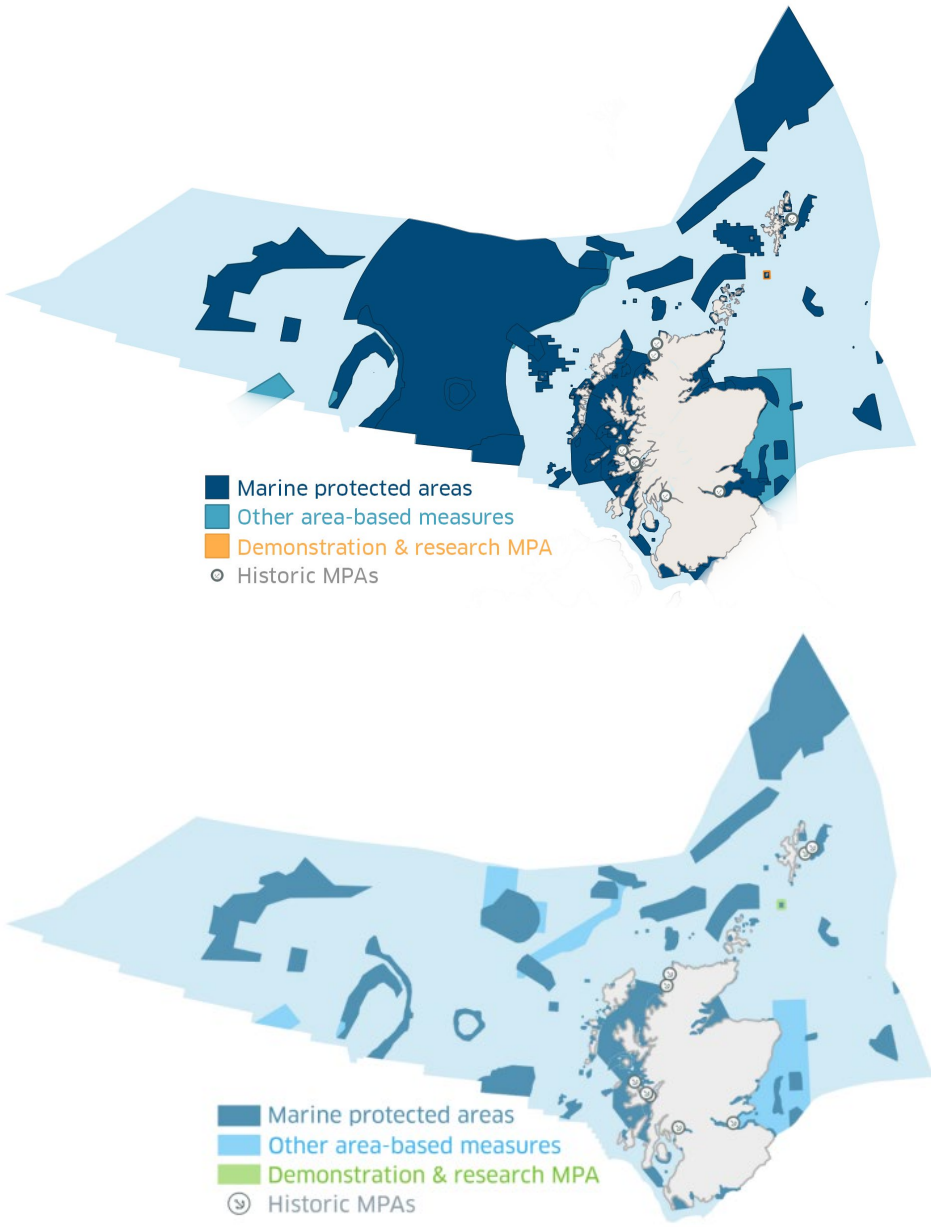
- **The Scotland Marine Assessment 2020 showed mixed progress.** As part of the Marine Plan Review, Scottish Government commissioned the Scotland Marine Assessment 2020 to provide an overview of the state of Scotland's marine environment. The assessment found:
  - Climate change is the most critical factor affecting Scotland's marine environment, including recent evidence which shows ocean acidification may have an impact on Scotland's shellfish and other marine invertebrates.
  - There are mixed indicators for marine mammals, birds and fish population abundance trends and signs of negative change in plankton populations:
    - Since 2011, overall trends in seabird populations have largely been stable.
    - The UK Marine Strategy target for 'no loss in extent' for subtidal biogenic habitats (e.g. mussel beds, cold water coral and maerl beds) has not been met in some Scottish Marine Regions.
  - There is insufficient data for a detailed assessment of marine regions (inshore and offshore) and too few ecosystem sites which are monitored

- **Fish size classes in the North Sea has declined.** In 2019, large fish in the North Sea (more than 50cm in length) made up only 6% of the weight of the fish population, demonstrating a steep decline from 13% in 2015, associated with overfishing and/or the effects of increased sea temperature.[19]

* Highly protected marine areas will provide environmental protection above the existing MPA network, including protection from all extractive, destructive or depositional activities such as fisheries, aquaculture and infrastructure developments. Scottish Government are in the process of developing the policy framework for this level of protection.

- **Sustainability of fish stocks data was not available.** Data on the sustainability of fish stocks was being reported annually under the National Performance Framework and was showing an increasing trend. However, this indicator has not been updated since 2018 so it was not possible to include an updated assessment here.

Figure 2.3 Map of Scotland's Marine Protected Area network in 2021 (top) and 2018 (bottom)



Source: Marine Scotland Directorate

5. Commercial forestry

Progress summary – Commercial forestry
Plan score: High • The Forestry Strategy identifies adaptation and resilience as a priority and the Forestry Strategy Implementation Plan outlines relevant actions. There is a monitoring and evaluation framework and the first report is expected in 2022. • Forestry and Land Scotland have made good progress to develop an adaptation plan and increase awareness of climate risks among staff **Risk management score: Medium** • Certified woodland area has increased over time; however, data on pests and pathogens in Scotland is limited and as a result plant health remains a concern • Further indicators will be reported on as part of Scotland's Forestry Strategy Implementation plan in future
Relevant risks from CCRA3: • N5 Risks and opportunities for natural carbon stores, carbon sequestration and GHG emissions from changing climatic conditions, including temperature change and water scarcity • N6 Risks to and opportunities for agricultural and forestry productivity from extreme events and changing climatic conditions (including temperature change, water scarcity, wildfire, flooding, coastal erosion, wind and saline intrusion) • N8 Risks to forestry from pests, pathogens and invasive species • N9 Opportunities for agricultural and forestry productivity from new/alternative species becoming suitable. More information on the related risks can be found in CCRA technical report chapter 3, Scotland National Summary, Land Use, Land Use Change and Forestry Briefing.

a) Introduction

This adaptation priority covers commercial forestry in Scotland.

Commercial forestry will be affected by climate change, although there are also opportunities for new or alternative species.

This priority area will be affected by changing climatic conditions, including temperature change, water scarcity, extreme events, wildfire, flooding, coastal erosion, wind and saline intrusion, and by pests, pathogens and invasive species. Increased drought risk in central and eastern Scotland can affect growth and timber quality and result in more drought-tolerant species having a competitive advantage over Sitka spruce, with impacts on oak and beech also projected to be severe. Pests and pathogens such as Ramorum disease, Dothistroma needle blight and bark beetles are already spreading across Scotland and are expected to spread further with higher moisture and temperature levels in future. There are also opportunities for forestry productivity from new or alternative species becoming suitable under the changing climate.

This priority area does not consider trees and woodland outside of commercial production; these are covered in Terrestrial Species and Habitats.

Within this priority area, all matters relating to forestry are devolved, although there is significant cooperation between forest management organisations across the UK, including on plant health. There is a UK Forestry Standard for sustainable forest management which applies across all of the UK, including Scotland.

b) Planning

The overall plan score for this priority area is **high.**[*] The Forestry Strategy identifies adaptation and resilience as a priority, and the Forestry Strategy Implementation Plan outlines relevant actions. There is a monitoring and evaluation framework and the first report is expected in 2022. Forestry and Land Scotland have developed an adaptation action plan and guidance for their staff on relevant climate risks.

Scottish Forestry have identified adaptability and resilience of woodlands are one of six priorities in the next ten years.

- **Adaptation actions.** Scotland's Forestry Strategy 2019-2029 and the accompanying Forestry Strategy Implementation Plan 2020-2022 include consideration of adaptation, with some adaptation-relevant objectives. Scotland's Forestry Strategy presents a long-term vision for Scotland's forests and woodlands, identifying 'increasing the adaptability and resilience of forestry and woodlands' as one of its six priorities in the next ten years. The accompanying Scotland's Forestry Strategy Implementation Plan 2020-2022 contains actions for implementing the strategy, although not all of the adaptation actions are related solely to climate change. The most relevant actions are to:

  - Develop a programme of actions to improve the resilience of Scotland's national forests and land to the impact of climate change and tree health threats.

  - Publish practice guidance and support training for forestry managers on the threats to Scotland's forests and how forest design and management can improve forest resilience;

  - Create a forest resilience 'resource' to provide the latest evidence on risks and approaches to improve forest resilience, and to engage the forestry sector and stakeholders on the key findings from this evidence;

  - Invest in research, surveillance and monitoring to improve understanding of the threats to Scotland's forests and woodlands and improve forest resilience;

  - Develop the Tree Health Service in response to emerging threats and improved understanding of specific pests and diseases, including exploring the feasibility of new technology to enhance monitoring.

  Work on the first action has now been completed by Forestry and Land Scotland. Work on the second action is ongoing and will include guidance on designing and managing woodlands and forests to reduce flood risk, as well as guidance on adapting forest and woodland management for the changing climate.

[*] Relevant strategies and policies relating to commercial forestry are: The Scotland Forestry Strategy 2019-2029; the Forestry Strategy Implementation Plan 2020-2022; Forestry; Land Scotland (FLS) Adaptation Action Plan for the National Forests and Land and Forestry and Land Scotland's Climate Change Plan (2022).

- **SMART objectives.** The Implementation Plan (2020-2022) includes objectives for increasing adaptability and resilience, but they are not fully SMART, with some being difficult to accurately measure and others not appropriately specific. For example, 'use incentives, regulation and partnership working to protect and improve native woodland condition'. The Forestry and Land Scotland (FLS) Adaptation Action Plan includes objectives which are time-bound, specific, relevant and achievable, although they are difficult to measure, for example, 'staff are supported to use guidance to decide what adaptation measures to take'.

- **Monitoring and evaluation.** A monitoring and evaluation system is included in the Implementation Plan, with a set of high-level indicators to track progress against the strategy. The indicators include the area of woodland creation, a woodland ecological condition score, the area of forests and woodlands covered by management plans. There are no indicators included on pests and pathogens, although this is being explored. The first report on the Forestry Strategy is expected to be published after March 2022.

- **Multiple climate scenarios.** The Scotland Forestry Strategy and Implementation Plan do not explicitly consider multiple future global warming levels. The FLS staff guidance on climate change impacts does include higher temperature scenarios and their potential impacts on forests. The FLS Adaptation Action Plan includes a commitment to plan for at least 2°C of warming.

When considered in combination, the Scotland Forestry Strategy 2019-2029, Forestry Strategy Implementation Plan 2020-2022, the FLS Adaptation Action Plan and the FLS staff guidance present a credible overall plan for adaptation in commercial forestry. While FLS manage 32% of Scotland's forests,[20] guidance is also being developed to support the implementation of the UKFS requirements, which will help landowners to consider adaptation.

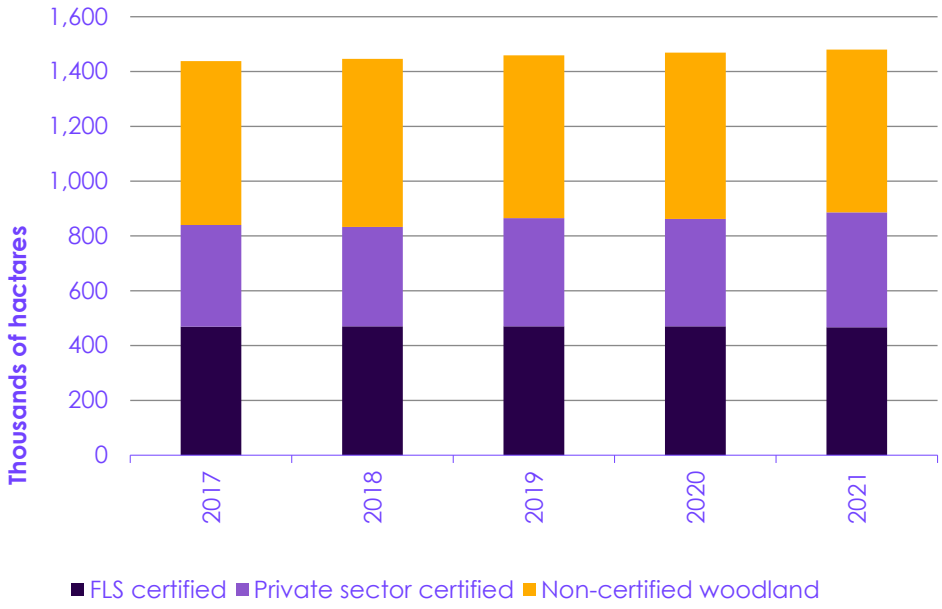
c) Risk management score

Certified woodland area is increasing but indicators for plant health are less positive.

The risk management score is **medium,** as certified woodland area has increased over time; however, data on pests and pathogens in Scotland is limited. High priority forest pests in the UK rose during the period 2019-2020 and then dropped to 2018 levels. There was a significant increase in sites that were served a statutory plant health notice in Scotland, indicating that plant health may have deteriorated.

- **Certified woodland area has increased.** Overall area of certified woodland (an indicator of sustainable forest management, that is likely to therefore be more resilient to climate changes) has increased slightly in Scotland, primarily in the private sector (see Figure 2.4).

Figure 2.4 Certified Woodland Area in Scotland

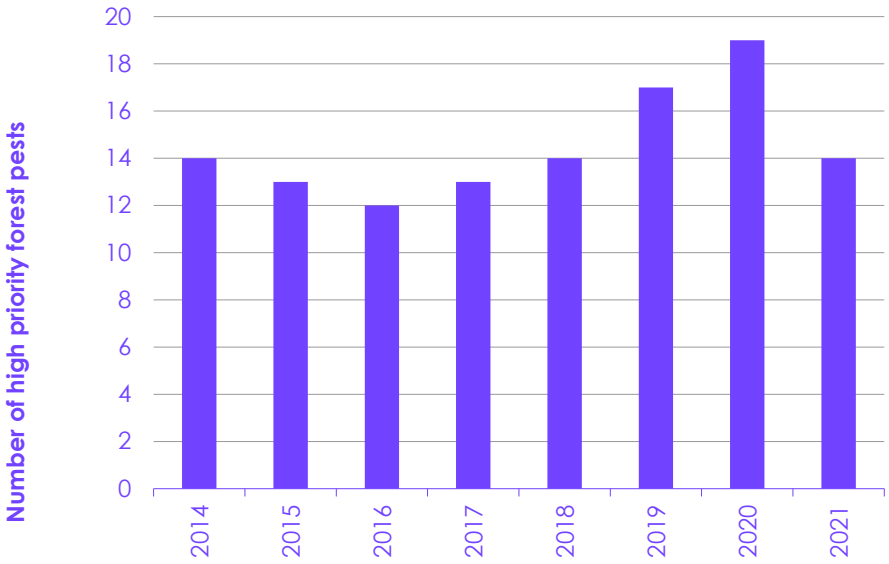


Source: Forest Research (2021) Certified woodland areas. [21]

- **Forest Research has developed a Climate Matching Tool to help practitioners consider the selection of better suited tree species** for environments that England may experience in the future. Underpinning the tool is UKCP18 climate data at 12km resolution using the RCP8.5 pathway in future projections.

- **The number of high priority forest pests in the UK rose briefly and then returned to 2018 levels.** The UK Plant Health Risk Register recorded a sharp increase in the number of high priority forest pests in the UK, rising from 12 in 2016 to 19 in 2020, as shown in Figure 2.5. Data for Scotland was not available.

Figure 2.5 Number of high priority forest pests in the UK Plant Health Risk Register



Source: Forestry Commission (2021) *Key Performance Indicators: Report for 2020-2021.*[22]

- **The number of sites where a statutory plant health notice was served has risen significantly in Scotland.** Statutory plant health notices are served by the Forestry Commission and require tree owners to fell trees with the aim of destroying infection or infestation of an alien invasive species to prevent it from spreading. In the last three years, the number of woodland sites in Scotland where a statutory plant health notice has been served rose from 70 in 2018 to 284 in 2021, an increase of 300%.[23]

6. Agricultural productivity

Progress summary – Agricultural productivity
Plan score: low • There is currently no strategy in place to ensure the agricultural sector in Scotland remains productive as the climate changes. • Current efforts to build the agricultural sector's ability to adapt to the impacts of climate change are a patchwork of initiatives, resulting in significant gaps in policy. **Risk management score: low** • Indicators to measure how the capability of the agricultural sector is changing in relation to climate change have not been updated since the Committee's last assessment of adaptation progress in Scotland. It is, therefore, not possible to conduct a robust assessment of changes in the vulnerability of agricultural production to climate change.
Relevant risks from CCRA3: • N4 Risks to soils from changing climatic conditions, including seasonal aridity and wetness • N6 Risks to and opportunities for agricultural and forestry productivity from extreme events and changing climatic conditions (including temperature change, water scarcity, wildfire, flooding, coastal erosion, wind) • N7 Risks to agriculture from pests, pathogens, and invasive non-native species. More information on the related risks can be found in CCRA technical report chapter 3, Scotland National Summary, Agriculture and Food Sector Briefing.

a) Introduction

The agricultural productivity priority considers the impacts of current and future climate change on the delivery of key services, notably domestic food production. It assesses the level of innovation and flexibility in agriculture, including adaptive agricultural practices; the resilience of crops and livestock to the effects of changing average climate and weather extremes (including pests and diseases); and the resilience of the underpinning natural assets (e.g. soils and water) that support agriculture.

A warming climate has the potential to increase the productivity of agriculture in Scotland, for example, due to longer growing seasons. [24] However, agricultural production will not be able to take advantage of any potential benefits if climate change degrades land capability overall. Aspects of climate change pose risks to maintaining land capability, ranging from more intense and frequent heatwaves and rainfall to increased flood risk, possible increases in the spread of pests and diseases. Certain management practices (e.g. deep ploughing, short rotation periods and exposed ground leading to soil erosion from wind and heavy rain) can also damage land capability, making agricultural land less resilient to future climate changes. Climate impacts on agriculture in Scotland are already being seen today. Increased soil moisture deficits and variability in summer rainfall are increasing needs for potentially costly irrigation in eastern Scotland, especially during drier summers. The total costs of soil erosion by water in Scotland (including in downstream locations) have been estimated at £31-50 million per year.

Climate projections for Scotland indicate more heavy rainfall days and an increase in winter rainfall – leading to projected increases in highest quality agricultural land at risk from fluvial flooding in Scotland by 26% by the 2050s and 31% by the 2080s in a global warming level of 2°C above preindustrial levels by 2100 scenario.[25*]

Most policy relating to this priority area is devolved to the Scottish Government.[†]

b) Planning score

The level of adaptation planning is scored as **low**. The agriculture sector still lacks a coherent strategy to ensure it remains productive under changing climatic conditions. A long-term strategy is required to prepare the agricultural sector in Scotland for the range of risks to and opportunities from climate change.

A new subsidy framework for agriculture will not come into effect until 2025.

The current policy framework in Scotland continues to follow the EU Common Agricultural Policy (CAP) in the short term while plans for a replacement agricultural strategy for Scotland are developed. The Scottish government has committed to maintaining much of the CAP system up until 2025, when it plans to start a move to a new subsidy framework. In August 2020, the Scottish parliament passed the Agriculture (Retained EU Law and Data) (Scotland) Act, which gave ministers the power to alter the inherited CAP regime. Several policy documents on Scotland's future subsidy regime have been published, but no final decisions have been taken.

- **Adaptation actions in plans:** Efforts to build the resilience of the agricultural sector to climate change are represented currently by a patchwork of policy initiatives. While the range of these initiatives will collectively go some way to supporting the sector's ability to adapt to future climate impacts, significant gaps persist. Examples of these policy initiatives are:
  - National Test Programme (NTS): The programme is scheduled to commence in spring 2022, with up to £51 million of investment over the following three years. The NTS will support and encourage farmers and crofters to learn about how their work impacts on climate and nature.
  - Agriculture Reform Implementation Oversight Board: The NTS is supported by an Agriculture Reform Implementation Oversight Board (ARIOB), which will help to develop new proposals for sustainable farming support by considering the Climate Change Plan Update (CCPu), including on soil health. However, as noted in Farmland Habitats and Species, the Climate Change Plan has a mitigation focus, with minimal consideration of current and future climate impacts.
  - Farming For a Better Climate: The initiative provides farmers with practical support to help them implement actions to reduce greenhouse gas emissions and to adapt to a changing climate. The online resource includes a checklist of adaptation actions linked directly to managing the risks to agriculture presented in CCRA2. It is not clear, however, the extent to which the resource is used, nor the

* Based upon the present area at risk and a 1:75 return period event.

† While most agriculture and environment policy relating to this priority is devolved to Scottish Government, some parts of the UK Agriculture Act 2020 and UK Environment Act 2021 apply to Scotland and some other policies of relevance for agriculture are reserved, for example the taxation of red diesel.

actions implemented by farmers. Data on Farming for a Better Climate will be included in the 2022 CCPu monitoring report.

– The Farm Advisory Service: The service aims to increase the profitability and sustainability of farms and crofts throughout Scotland through delivering advice, information and resources to farmers. While much of the support provided will help build on-farm resilience in general terms, the level of consideration given to future climate change impacts in the development of the advice is not clear.

– Farmer led Groups: Several climate change groups were established to develop advice and proposals to the Scottish Government on how to tackle climate change, including ones for the arable, dairy, and high nature value (upland farming/crofting) sub-sectors. While the groups' primary focus was emissions reduction, some consideration was given to the mitigation of other environmental impacts on production and enhancing sustainable land use, especially soil health and crop management.

Adaptation plans must be underpinned with monitoring and evaluation to respond to climate risks.

It is vital that effective adaptation plans are developed supported by a comprehensive set of actions and monitoring, if the key climate risks to the agriculture sector identified in CCRA3 are to be reduced to manageable levels. Actions include those related to flood risk and soil management, and improving the technological capability of the sector to respond to threats such as changing pest and disease risks.

A structured approach to incorporating the potential impacts from a changing climate into long-term land use planning is essential for land managers to successfully adapt to climate change. At present, there is only limited evidence that information about future impacts of climate change on agricultural production is taken into account sufficiently and that such long-term planning takes place. The Scottish Government needs to own and supply the required information, and there needs to be a mechanism for landowners to use it. The Government should implement this provision of support and information through the successor to the EU Common Agricultural Policy (CAP).

c) Risk management score

The management of climate risks for agricultural productivity in Scotland is assessed as **low**. Some progress has been made in the development of soil erosion risk maps. However, despite recent evidence of climate impacts from drought and flooding (see below), there remains a concerning lack of indicators to support the robust assessment of risks and opportunities from climate change to the agriculture sector in Scotland.

There is not enough data to assess how the agricultural sector is managing climate risks.

- **There is a lack of Indicators to measure how the capability of the agricultural sector is changing in relation to climate change.** The absence of an up-to-date set of adaptation indicators means that it is currently not possible to determine whether progress is being made by the Scottish agricultural sector in managing vulnerability to climate change. While there is evidence of actions taking place to build the resilience of the sector, this assessment was unable to locate any current datasets to support appropriate measurement of progress.

Areas where indicators are required include; data on the establishment of techniques to reduce water demand and increase water reuse and storage, information on the establishment and spread of new crops, indicators to measure changes in the level of agricultural expenditure on adaptation, and data to measure the ability of agricultural soils to support food production.

- **Good progress has been made in the development of maps of intrinsic risk for soil erosion and compaction.** The maps use texture, profile and slope data for the main agricultural areas, to help identify the most vulnerable locations. [26] When evaluated against changing climate exposure (rainfall intensity etc.), the maps can provide a basis for determining where additional adaptation actions, notably through land management, are likely to be necessary, although this currently remains a work in progress. The maps will provide a useful tool for landowners and managers.

- **During the hot dry summer of 2018, malt barley supply to Scotland's distilling and brewing sectors was impacted by quality and yield issues due to drought**. Low flows and higher water temperatures also impacted fermentation, cooling and overall whisky quality, with production at some distilleries halted for several weeks, significantly affecting one of Scotland's major export industries.

7. Commercial fisheries and aquaculture

Progress summary – Commercial fisheries and aquaculture
Plan score: Low • The National Marine Plan (2015) includes climate change adaptation but is missing the latest evidence on UK climate projections and climate risks. The River Basin Management Plan for Scotland (2021-2027) does not include adaptation actions. The Farmed Fish Health Framework includes limited adaptation actions and has not shown any progress on them since 2018. **Risk management score: Low** • The condition of freshwater environments has improved marginally since 2016 but climate impacts are increasing on marine species.
Relevant risks from CCRA3: • N14 Risks to marine species, habitats and fisheries from changing climatic conditions, including ocean acidification and higher water temperatures • N15 Opportunities to marine species, habitats and fisheries from changing climatic conditions • N16 Risks to marine species and habitats from pests, pathogens and invasive species • N11 Risks to freshwater species and habitats from changing climatic conditions and extreme events, including higher water temperatures, flooding, water scarcity and phenological shifts. • N12 Risks to freshwater species and habitats from pests, pathogens and invasive species • N13 Opportunities to freshwater species and habitats from new species colonisations More information on the related risks can be found in CCRA technical report chapter 3, Scotland National Summary, Marine and Coastal Environment Briefing, Freshwater Habitats Briefing.

a) Introduction

This adaptation priority covers the impacts of climate change on commercial fisheries and aquaculture. Marine ecosystems are affected by warming waters, variations in salinity, deoxygenation, changes in stratification (mixing of shallow warmer and deeper cooler waters) and acidification. Freshwater habitats are affected by warmer water temperatures, flooding, and water scarcity. For example, the timing of salmon migration in rivers has been found to be correlated with freshwater temperatures. Both marine and freshwater species are also affected by invasive non-native species (INNS).

The impacts of climate change on non-commercial marine and coastal species are covered in the priority area Marine and Coastal Habitats and Species.

Relevant policy in this priority area (marine and freshwater policy) is largely devolved to the Scottish Government in relation to activities affecting the marine environment in Scotland's inshore waters. UK Parliament legislates for Scotland's offshore waters, but certain matters in this area have been executively devolved. Marine planning matters in Scotland's inshore waters are governed by the Marine (Scotland) Act 2010, and in its offshore waters by the Marine and Coastal Access Act 2009.

Fisheries are legislated under the UK Fisheries Act 2020 and through the joint fisheries statement, but licensing for Scottish fishing boats is devolved to Scottish Ministers, and the Scottish Government may publish fisheries management plans under the Act.

b) Planning score

The level of adaptation planning is scored as **low.*** A changing climate is considered throughout the Marine Plan, but objectives are difficult to measure and do not include timeframes. More up to date climate risk evidence has been made available in the six years since the plan was published which could be included. The River Basin Management Plan for Scotland does not include actions on adaptation, and the Farmed Fish Health Framework includes very limited adaptation actions.

There are very limited actions on adaptation included in relevant plans for fisheries and aquaculture.

- **Adaptation actions in plans.** The Marine Plan (2015) considers adaptation across objectives and sectors, including a specific section on adaptation under each sector. The Farmed Fish Health Framework (2018-2028) includes a workstream on climate change and ocean acidification. Climate change is referenced in the River Basin Management Plan for Scotland (2021-2027), but there are no specific adaptation actions included in the plan. The Future Fisheries Management Strategy (2020) includes one action on adaptation, which is to consider where and how to adapt approaches to the impacts of climate change. The Finfish Aquaculture Sector Plan (2019) only mentions climate impacts in passing, without specific adaptation actions.

- **SMART objectives.** The Marine Plan includes objectives across 11 marine sectors. These objectives are appropriately specific, achievable, and relevant. They are largely not measurable or time bound. It is therefore difficult to assess to what extent the plan has been successfully implemented. The Farmed Fish Health Framework only includes two actions on climate adaptation, which do not have more specific time frames than the ten-year framework.

- **Monitoring and evaluation.** The Marine Plan is reviewed every three years, according to UK legislation. The Farmed Fish Health Framework Working Group are due to produce progress reports every year, but only one progress report was publicly available for review from 2019.

- **Multiple climate scenarios.** The Marine Plan does not explicitly consider multiple climate scenarios. Its assessment of climate risks is based on the UK's first climate change risk assessment published in 2012, which uses UKCP09 projections. There are now more up to date UKCP18 climate change projections available from the Met Office and the latest independent assessment of UK climate risk was published in 2021, with four different relevant risks for marine and coastal habitats and species. The Marine Plan (2015) is likely to be missing consideration of some key climate risks as a result. The Farmed Fish Health Framework and the River Basin Management Plan do not consider multiple climate scenarios.

* Relevant strategies and policies relating to commercial fisheries and aquaculture are: the Marine Plan (2015); Regional Marine Plans; the River Basin Management Plan for Scotland (2021-2027); the Future Fisheries Management Strategy (2020); the Finfish Aquaculture Sector Plan (2019); the Farmed Fish Health Framework (2018-2028); and the River Basin Management Plans 2021-2027 (2021). No statutory Regional Marine Plans have been published to date. In the 2020-2021 Programme for Government the Scottish Government committed to the development of a Blue Economy Action Plan which has not yet been published. A Wild Salmon Strategy was also announced in the 2019/2020 programme for Government.

c) Risk management score

The management of climate risks to marine and coastal habitats and species is scored as **low**. The overall condition of freshwater has improved slightly, but climate impacts on marine fish are increasing.

- **Overall condition of the water environment has improved slightly.** In their River Basin Management Plan 2021-2027, SEPA reports that in 2020, 66% of the water environment was in good condition or better. This is a modest improvement of 3% since the previous River Basin Management Plan was published in 2016.[27]

Recent updated evidence from the Marine Climate Change Impacts Partnership shows fishery productivity has been negatively impacted by ocean warming.

- **The Marine Climate Change Impacts Report Card 2020 shows poor progress.** The report card summarises the latest evidence on impacts of climate change on UK coasts and seas. The report card presents evidence of largely negative impacts on fisheries and aquaculture, as well as some missed opportunities.[28]
  - Fisheries productivity in some UK waters has been negatively impacted by ocean warming and historical overexploitation.
  - The variety and abundance of marine fish has changed significantly off the west of Scotland over the past three decades, with mackerel increasingly dominant.
  - Warming and associated oxygen solubility appears to be affecting the age at maturation, growth rates and the maximum size fish can attain.
  - Declines in primary production have led to declines in the numbers of fish reaching maturity (fish stock recruitment) for some commercial species, including cod, herring, whiting and sprat.
  - There are increasing problems with invasive species, fish gill diseases and contamination of shellfish linked to changes in the climate.

8. Water management

Progress summary – Water management
Plan score: medium • The Scottish Environment Protection Agency (SEPA) published the latest River Basin Management plan for Scotland at the end of 2021. According to SEPA, at present only current risks from water shortages and higher water temperatures are taken into consideration when developing actions, although this is not evident in the plans. • Natural flood management will represent a central feature of the updates to flood risk management plans in Scotland, which will be accompanied by supporting government guidance on the use of Nature-based Solutions (NbS) to manage flood risk. **Risk management score: medium** • Indicators available suggest a high proportion of water flows and level in Scotland to be in good or improving condition. • There is an insufficient level of appropriate indicators to adequately assess how the vulnerability of the water environment for providing water for human use is changing under climate change. • The use of land for natural flood management remains poorly recorded.
Relevant risks from CCRA3: • N4 Risks to soils from changing climatic conditions, including seasonal aridity and wetness • N6 Risks to and opportunities for agricultural and forestry productivity from extreme events and changing climatic conditions (including temperature change, water scarcity, wildfire, flooding, coastal erosion, wind) • N10 Risks to aquifers and agricultural land from saltwater intrusion • N11 Risks to freshwater species and habitats from changing climatic conditions and extreme events, including higher water temperatures, flooding, water scarcity and phenological shifts • N17 Risks and opportunities to coastal species and habitats due to coastal flooding, erosion, and climate factors More information on the related risks can be found in CCRA technical report chapter 3, Scotland National Summary, Water Sector Briefing.

a) Introduction

This adaptation priority considers the regulating services* related to the availability and quality of water in the Scottish environment, and flood risk management provided by the natural environment. In particular, this priority area focuses on the use of water and its management to prevent food risk. Biodiversity in the water environment is covered in Freshwater Habitats and Species.

* Regulating services are the benefits to society that result from ecosystem processes, often moderating human impacts, such as: carbon sequestration and storage, water regulation and purification, erosion control, pollination, and protection from extreme weather and climatic events.

Climate change impacts in relation to regional water scarcity and drought and higher water temperatures were identified in CCRA3 as an urgent risk to people, businesses, infrastructure, agriculture and wildlife.

CCRA3 found the magnitude of current and future risk is judged to be medium by the 2050s. However, with increasing volumes of evidence on specific impacts, this risk could increase to high by the 2080s* due to the greater likelihood of larger changes in water temperature, river flows and water quality.

All policy relating to this priority area is devolved to the Scottish Government.

b) Planning score

The level of adaptation planning is scored as **medium.** While it is understood risks from water shortages and higher water temperatures are taken into consideration when developing actions to support river basin management planning, this is not evident in the plans and only relates to current climate impacts. The use of the natural environment or Nature-based Solutions (NbS) to manage the risks of flooding in Scotland will represent an integral part of the new Flooding Service Strategy.

River basin management plans (RBMPs) are the main mechanism used to improve water quality and protect the supply of water from environment to people, wildlife and the economy. They are produced every six years by SEPA on behalf of the Scottish Government. SEPA also produces flood risk management plans every six years and is producing a flooding service strategy.

The latest River Basin Management Plans do not include specific actions on adaptation.

- **Adaptation actions in plans.** The third cycle RBMPs covering the period 2021 to 2027 were published at the end of 2021. According to SEPA, at present only current risks from water shortages and higher water temperatures are taken into consideration when developing actions, although this is not evident in the plans. While the plans set out a range of actions allocated by authorities responsible in Scotland, they lack specific adaptation activities to support management in a changing climate. Nature-based solutions (NbS) to manage the risks of flooding in Scotland will represent an integral part of the new Flooding Service Strategy.† Actions to meet the Strategy's objectives will be delivered via 14 Local Flood Risk Management (FRM) plans. The plans, which are scheduled to be published at the end of 2022, will consider updated climate data from UKCP18. Natural flood management (NFM) is a central feature of the FRM plans; however, it is not clear at this stage which NbS will be covered. Also in 2022, to assist practitioners in selecting appropriate NFM measures, SEPA will publish guidance on the use of natural processes to manage flood risks whilst enhancing ecosystem services, together with further information around the monitoring of FRM plans.

- **SMART Objectives.** The River Basin Management Plan includes objectives which are largely SMART, although some are ambiguous or difficult to measure. For example, 'SEPA will work with a number of distilleries to reduce the impact of their operations on the water environment'.

* 'High' score based on a +4°C at 2100 scenario.

† The Flooding Service Strategy aims to transform the policy direction in Scotland to focus on the challenge of adapting to a changing climate. The strategy was consulted on in the Autumn of 2020 and is due for publication in mid-2022.

c) Risk management score

There is not enough data to assess how climate risks are being managed.

The Water Management in Scotland priority is scored as **medium**. The available measures suggest a relatively high proportion of water flows and level are in good or improved condition. However, there is an insufficient number of appropriate indicators to adequately assess how the vulnerability of the water supply is changing under climate change. Furthermore, the use of land for natural flood management remains poorly recorded.

- **Data suggests the percentage of flows and levels of water that are in good or better condition remains relatively high.** Monitoring water resources (the flows and levels of water) indicates how much water is being used and how much is available to serve all its vital functions, including to support the natural environment. The flows and levels in Scotland's water environment are currently in good or better condition in 90% of the places monitored[29].

- **Data on water abstraction licenses or regulation are not published publicly.** SEPA regulates abstraction of water based on three authorisation levels: general binding rules, for activities considered a low risk; registration for activities that pose low individual risk; and licensing for activities that pose a moderate to high risk to the environment. Most abstraction licenses require the operator to submit data returns to SEPA, but this data was not publicly available for review.

Endnotes

[1] European Commission (2021) *Factsheet on 2014-2020 Rural Development Programme for Scotland (UK)*. Available at: https://ec.europa.eu/info/sites/default/files/food-farming-fisheries/key_policies/documents/rdp-factsheet-scotland_en.pdf

[2] Scottish Government News (2020) *Continuing CAP for Scotland's farmers.* Available at: https://www.gov.scot/news/continuing-cap-for-scotlands-farmers/

[3] Pakeman, R., Gimona, A., Glendell, M., Yeluripati, J., Addy, S., van Hulst, F. et al. (2018) Climate Change, Natural Capital and Adaptation in Scotland's Marginal Lands. Retrieved from: https://www.climatexchange.org.uk/research/projects/climate-change-natural-capital-andadaptation-in-scotland-s-marginal-land

[4] Neilson, R., Lilly, A., Aitkenhead, M., Artz, R., Baggaley, N., Giles, M. et al. (2020) *Measuring the vulnerability of Scottish soils to a changing climate.* ClimateXChange Scotland. http://doi.org/10.7488/era/546

[5] Neilson, R., Lilly, A., Loades, K. (2021) *Monitoring soil health in Scotland by land use category – a scoping study.* ClimateXChange Scotland https://doi.org/10.7488/era/1293

[6] European Commission (2021) *Factsheet on 2014-2020 Rural Development Programme for Scotland (UK)*.

[7] NatureScot habitat types. Available at: https://www.nature.scot/landscapes-and-habitats/habitat-types

[8] Scottish Government (2021) *Update to the Climate Change Plan 2018-2032: Securing a Green Recovery on a Path to Net Zero.* Available at: https://www.gov.scot/publications/securing-green-recovery-path-net-zero-update-climate-change-plan-20182032/documents/

[9] NatureScot (2019) *Scotland's Biodiversity A Route Map to 2020 Third Progress Report – 2017/19.* Available at: https://www.nature.scot/doc/biodiversity-route-map-2020-3rd-year-report-2017-2019

[10] NatureScot (2019) *Scotland's Biodiversity A Route Map to 2020 Third Progress Report – 2017/19.*

[11] NatureScot, (2019) *Scotland's Biodiversity A Route Map to 2020 Third Progress Report – 2017/19.*

[12] Bat Conservation Trust (2021) *The National Bat Monitoring Programme Annual Report 2020.* Bat Conservation Trust, London.

[13] UK Butterfly Monitoring Scheme (2020) *2020 Country-level Summary of Changes tables for England, Scotland, Wales and Northern Ireland.* Available at: https://ukbms.org/official-statistics

[14] Simon-Nutbrown, C., Hollingsworth, P.M., Fernandes, T.F., Kamphausen, L., Baxter, J.M., Burdett, H.L. (2020). Species Distribution Modeling Predicts Significant Declines in Coralline Algae Populations Under Projected Climate Change With Implications for Conservation Policy. Frontiers in Marine Science, 7, 575825. https://doi.org/10.3389/fmars.2020.575825

[15] Marine Scotland Directorate, https://www.gov.scot/policies/marine-environment/marine-protected-areas/

[16] Scottish Government (2018) *Marine Protected Area Network – 2018 Report to the Scottish Parliament.* https://www.gov.scot/publications/marine-protected-area-network-2018-report-scottish-parliament/documents/

[17] UN Convention on Biological Diversity (2021) *Draft Global Biodiversity Framework,* https://www.cbd.int/article/draft-1-global-biodiversity-framework

[18] Scottish Government (2020) *Protecting Scotland, Renewing Scotland: The Government's Programme for Scotland 2020-2021*, https://www.gov.scot/publications/protecting-scotland-renewing-scotland-governments-programme-scotland-2020-2021/

[19] Joint Nature Conservation Committee (2021) *UK Biodiversity Indicators.* https://jncc.gov.uk/our-work/ukbi-d1a-fish-size-classes/

[20] Forest Research (2021) *Forestry Statistics 2021, Chapter 1: Woodland Area & Planting.* Available at: https://www.forestresearch.gov.uk/documents/8143/Ch1_Woodland_FS2021.pdf

[21] Forest Research (2021) *Certified woodland areas.* Available at: https://www.forestresearch.gov.uk/tools-and-resources/statistics/data-downloads/

[22] Forestry Commission (2021) *Forestry Commission Key Performance Indicators: Report for 2020-2021. Available* at: https://www.gov.uk/government/statistics/forestry-commission-key-performance-indicators-report-for-2020-21

[23] Forest Research (2021) *Forestry Statistics 2021.* Available at: https://www.forestresearch.gov.uk/documents/8205/Complete_FS2021_JvYjBWA.pdf

[24] Berry, P. and Brown, I. (2021) *National environment and assets. In: The Third UK Climate Change Risk Assessment Technical Report* [Betts, R.A., Haward, A.B. and Pearson, K.V. (eds.)]. Prepared for the Climate Change Committee, London

[25] Evidence for the third UK Climate Change Risk Assessment (CCRA3): Summary for Scotland (2021).

[26] Lilly, A., Baggaley, N. J., Loades, K. W., McKenzie, B. M. and Troldborg, M. (2018) *Soil erosion and compaction in Scottish soils: adapting to a changing climate.* ClimateXChange.

[27] SEPA (2021) *River Basin Management Plan for Scotland 2021-2027.* Available at: https://www.sepa.org.uk/media/594088/211222-final-rbmp3-scotland.pdf

[28] Marine Climate Change Impacts Partnership (2020) *Marine Climate Change Impacts: Report Card 2020*

[29] SEPA (2021) *River Basin Management Plan for Scotland 2021-2027.* Available at: https://www.sepa.org.uk/media/594088/211222-final-rbmp3-scotland.pdf

Chapter 3

Health

Table 3
Progress summary - Health

Adaptation Priority	Plan Score	Risk Management Score
Resilience of the population to changes in temperature	Medium	Low
Resilience of people to pathogens	Low	Low
Air quality	Medium	Medium

This chapter assesses progress in adapting to climate change for risks related to human health.

This chapter reviews progress on adapting to the weather and climate risks to people's health and wellbeing. These include high temperatures and heat waves, which will become increasingly frequent and intense as the climate warms. Future projections estimate that without additional adaptation action, heat-related deaths in Scotland could increase to 70 - 285 per year by 2050, assuming no population growth.[1]

Changes in weather patterns in the UK (e.g., blocking highs*) can have knock-on impacts on air pollution levels, although the understanding of possible shifts in atmospheric circulation is still limited. Changes in the Scottish climate, such as towards warmer and wetter summers, could lead to increased prevalence of infectious and non-infectious diseases, such as Lyme disease. There are more reported cases of Lyme disease in Scotland compared to other parts of the UK due to higher humidity and outdoor tourism, both of which are likely to increase in the future with climate change.

The key points from the assessment are:

- **Current policies and regulations are not ensuring that homes built today are resilient to future warmer temperatures.** Energy efficiency, overheating and ventilation need to be considered together when retrofitting or building new homes so that measures to improve air tightness do not lead to increased overheating and reduced indoor air quality. There is no evidence that this is occurring yet at large scale in Scotland.

- **There is a lack of plans and policies for managing risks of more prevalent climate-sensitive diseases**. A measured increase in Lyme disease cases over recent years highlight the potential for sustained increases in case numbers as the climate warms. This risk is not currently being managed.

* Periods of stable air and long-lasting high pressure over the UK that mean pollution concentrations can rise to hazardous levels.

- **Future climate conditions are being adequately considered in current outdoor air quality strategies but not in relation to indoor air quality.** New standards for ventilation are currently being consulted on but further research is needed to understand the impact of energy efficiency measures on indoor air quality.

- **Availability of data to measure the level of risk remains limited for most of the priority areas in this chapter.** It is essential that this gap is closed as a priority to ensure that effective policy and investment choices can be made to support the health of Scotland's population under the warmer conditions expected in the future.

Recommendations for improving the quality of adaptation planning and the ability to manage the risks are set out in Table 3.1.

Table 3.1
Health recommendations

Priority Area	Recommendations
Resilience of the population to changes in temperature	Scottish Government should regulate the overheating provision as set out in the Energy Standards consultation. Expand the requirement to cover refurbishments and retrofit of existing buildings and conversions of non-domestic buildings to residential and incentivise measures for retrofitting passive cooling measures in existing homes. Scottish Government should include adaptation actions in the Housing to 2040 Strategy and route map to consider future increases in extreme weather, including overheating, to meet its aims to have houses that are fit for the future and that avoid expensive future retrofitting. Scottish Government should conduct or commission time series analyses of mortality data to identify trends and how vulnerability to cold and heat is evolving.
Resilience of people to pathogens	Public Health Scotland should assess the changing risks to people from vector-borne diseases, making use of the most recent Independent UK Assessment of Climate Risk. This should consider areas for future monitoring and surveillance.
Air Quality	Scottish Government should regulate ventilation as set out in the Energy Standards consultation. Ensure that Building Regulations simplify and clarify guidance on ventilation in homes to ensure good indoor air quality and comfort to occupants.

There are three priority areas assessed in this chapter:

1. Resilience of the population to changes in temperature
2. Resilience of people to pathogens
3. Air quality

1. Resilience of the population to changes in temperature

Progress summary – Resilience of the population to changes in temperature

Plan score: Medium

- A changing climate has been integrated into some policies and strategies in this area but is missing from others. The new Housing to 2040 Strategy does not include any climate adaptation measures, undermining its aims to ensure houses are fit for the future. The draft Heat in Buildings strategy does not explicitly include climate change adaptation.
- A consultation on changes to *Energy Standards* within Scottish building regulations proposes a new provision to assess and mitigate against the risk of summertime overheating in all new dwellings. The consultation includes methodologies that account for climate change and use high emissions scenarios from UKCP09.

Risk management score: Low

- In general, there is a lack of relevant data to assess progress effectively in this priority. There are data on fuel poverty rates, however there is a lack of data on temperature-related mortality and morbidity; to monitor and assess the risk of overheating in homes, hospitals, care homes, schools, offices and prisons; and to monitor changes to urban greenspace.

Relevant risks from CCRA3:

- H1: Risks to health and wellbeing from high temperatures.
- H2: Opportunities for health and wellbeing from warmer summers and winters.
- H6: Risks and opportunities from summer and winter household energy demand.
- H12: Risks to health and social care delivery.
- H13: Risk to education and prison services.

More information on the related risks can be found in CCRA technical report chapter 5, Scotland National Summary, High Temperatures Briefing, Health and Social Care Sector Briefing, Housing Sector Briefing.

a) Introduction

This adaptation priority covers preparing for the health and well-being consequences of changes in the frequency and intensity of extreme cold and heat conditions that will occur over the coming decades. It considers the adequacy of Scottish building stock, as many heat-related health impacts occur due to sustained exposure to high temperatures whilst indoors.

In future, summers and winters in Scotland will be significantly warmer which will affect people's health.

Temperatures across Scotland are increasing, and Scotland will see significantly warmer winters and summers under all future climate scenarios. At 2°C of global mean warming, both hot and cool summer days will warm by 1 to 1.5°C across Scotland in the 21st century.[2] By 2100 many areas could see daily temperatures exceed 30°C with greater frequency.[3] This increase in warm-temperature extremes will have effects on health, particularly for vulnerable and elderly people. While Scotland has lower temperatures relative to some other regions of the UK, one model estimates that there were 35 heat-related deaths per year in Scotland on average in the 2000s, which could increase more than seven times to 285 deaths per year by 2050.*[4]

* Temperatures and heat-related mortality starts to increase at lower temperatures in Scotland compared to more southern areas.

Winter cold-related health impacts and mortality will reduce with additional future climate change but will remain significant in all future climate scenarios over the coming decades.

Planning and building regulation policy is fully devolved to the Scottish Government. The Scottish building standards system is established by the Building (Scotland) Act 2003 which regulates new and existing buildings.

b) Planning score

The consideration of a changing climate in planning for this area is scored as **medium**.* There is mixed progress in integrating a changing climate into the key policies and strategies in this area.

- **Adaptation actions in plans.** Relevant plans within this priority area cover residential buildings, schools and the health system:

There is a risk that new homes built today which do not account for future climate change will lock in future overheating and require costly retrofitting.

  – Residential buildings: The Housing to 2040 Strategy and the Draft Heat in Buildings Strategy do not include any objectives relating to climate change adaptation, despite its aims to avoid future retrofitting and to ensure 'that new homes are fit for the future and do not need to be retrofitted later.' This creates a risk of locking in new and long-lasting housing stock that is at risk of future overheating without further and potentially costly retrofitting. However, the Scottish Government has committed to reduce vulnerability to cold and fuel poverty, for example announcing a programme to provide over £64 million in 2021/22 to enable local authorities in Scotland to delivery energy efficiency measures for fuel poor households and communities. [5] The Fuel Poverty (Targets, Definition and Strategy) (Scotland) Act came into effect in 2019, and the 2020 Budget and Programme for Government included £1.6 billion over the next five years for heat and energy efficiency measures.[6] A new fuel poverty strategy was published at the end of 2021 to make progress towards the legislated targets.

    The next National Planning Framework (NPF4) was published in draft form in Autumn 2021. Development proposals are required to reduce overheating without reliance on air conditioning systems as far as possible. Proposals for buildings that will be occupied by people should be designed to promote sustainable temperature management, including where possible prioritising natural or passive solutions.

There is currently a consultation to assess and mitigate against summertime overheating, but it only covers new buildings.

    Provisions for temperature control in buildings are currently set out in the Building Regulations Technical Handbook with limited consideration of overheating risk to health of building occupants. A recent consultation on Energy Standards proposes a new provision to assess and mitigate against the risk of summertime overheating in all new dwellings for specific designs and locations.[7] This provision is an improvement, although industry standards should be reviewed regularly to ensure the most appropriate climate scenarios are used. Conversions from non-domestic to residential are included in the draft guidance. [8]

* Relevant strategies and policies relating to the resilience of the population to changes in temperature are: the Heat in Buildings Strategy (2021); Housing to 2040 Strategy (2021); The Fuel Poverty Strategy (2021) and 2019 Act; National Planning Framework 4; the current building standards regulations (most recently revised in 2019); and NHS Scotland's draft Climate Emergency and Sustainability Strategy (2021).

If implemented this will be an important step forward in mainstreaming consideration of overheating risk in new builds, although it does not include retrofits of existing buildings.

- Schools: Scotland's Adaptation plan states that the Schools For the Future Programme, which will invest £2.8 billion in constructing, rebuilding and refurbishing over a hundred schools across Scotland, will ensure that new and refurbished schools are fit for climate change, although there is little information on how this will be achieved.

- Health Service: NHS Scotland has published a draft Climate Emergency and Sustainability Strategy (2022-2026) which includes a section on climate change adaptation and acknowledges overheating in Scotland's hospitals as a key risk. It also commits to prioritising passive cooling where possible; and to establish a monitoring programme to capture data on overheating at in-patient facilities, among other actions. [9]

NHS Scotland have completed a climate change impact assessment and all NHS Boards are developing adaptation plans.

NHS Boards are required to produce adaptation plans and NHS National Services Scotland (NHS NSS) recently undertook an NHS Scotland-wide climate change impact assessment. Building on these initial studies, NHS NSS have now developed a climate change risk assessment tool that enables NHS Boards to assess their climate risks and integrate these assessments into resilience planning at each site. Work is now in progress across all NHS Boards to transition from the initial impact assessment to full adaptation plans. NHS Scotland's Sustainability Assessment Tool enables NHS Scotland Boards to assess their sustainability performance across different areas of focus, including Climate Change Adaptation. These commitments and tools are an important improvement in understanding climate risks across NHS Scotland.

- Other public buildings: The Scottish Prison Service does not currently have a policy and strategy to mitigate future climate risks.

- **SMART Objectives and Monitoring and evaluation in plans.** The final Heat in Buildings Strategy will include a framework for monitoring and evaluation. The Fuel Poverty Act sets clear objectives for reducing fuel poverty to reduce the impacts of cold temperatures. It sets a statutory target that by the year 2040 no more than 5% of households in Scotland should be in fuel poverty. The 2040 targets must be achieved not only in Scotland as a whole, but also within each local authority area. The Act includes provisions for reviewing the strategy and regular progress reports.

- **Consideration of multiple climate scenarios.** Most plans do not account for different climate scenarios. The consultation on changes to Energy Standards includes methodologies that take account of climate change and use high emissions scenarios from UKCP09.

It is important that overheating and ventilation are considered together with energy efficiency measures.

Across public and residential buildings, it is important that measures to address energy efficiency, overheating and ventilation are considered together when retrofitting or building new so that measures to improve air tightness do not lead to increased overheating and reduced indoor air quality.

c) Risk management score

The management of climate risks within this priority area is scored as **low.** In general, there is a lack of relevant data to assess progress effectively in this priority.

Data suggests that heat related hospitalisations are increasing. The CCRA3 found that heat related deaths will also increase in Scotland.

- **Heat related hospitalisations appear to be increasing.** Health Protection Scotland reported 75 hospitalisations attributed to heatstroke, sunstroke or sunburn in the period January 2018 to October 2018. By comparison, there were 48 hospitalisations attributed to these causes for the calendar year 2017 and the average number of annual admissions from 2010 to 2017 was 43. [10] Heat-related mortality will be much larger than for these figures as it is related to an increase in heart and respiratory conditions, but heat is not recorded as a cause of death. More up to date data on heat-related morbidity were not available for this assessment, although the latest evidence from CCRA3 includes projections that heat related deaths will increase to around 70-285 per year by 2050. [11]

- **Temperature-related mortality data are not routinely produced.** Data on all-cause winter mortality are collected, but the seasonal analysis (the 'winter excess mortality') often reported includes deaths attributable to winter illness such as flu, rather than specifically to cold temperatures, meaning it is difficult to assess how cold-related mortality is changing over time. It is, however, possible to determine mortality attributable to cold and how it is changing over time, but this is not routinely done. Similarly, there are not sufficient data to monitor changes in the impacts of high temperatures on mortality and morbidity.

There is not enough data to monitor and assess the risk of overheating across different building types.

- **Scale of risk in existing buildings is unknown.** There is a lack of data to monitor and assess the risk of overheating in homes, hospitals, care homes, schools, offices and prisons. There is also a lack of data on changes to urban greenspace, which can provide cooling by reducing the urban heat island effect.

- **Fuel poverty is reducing.** In 2019 an estimated 24.6% - around 613,000 households - of all households were in fuel poverty. [12] This is similar to the 2018 fuel poverty rate of 25%, but lower than that recorded between 2012 and 2015. Despite a reduction in fuel poverty overall, between 2018 and 2019, rates of fuel poverty increased in remote areas (from 33% to 43%).

2. Resilience of people to pathogens

Progress summary – Resilience of people to pathogens
Plan score: Low • Food Standards Scotland has a strategy for reducing food-borne illness but there is limited reference to climate change included. There are no current plans relating to vector-borne diseases. **Risk management score: Low** • Data on pathogens affected by climate change are limited. The incidence of Lyme disease has increased significantly in recent years.
Relevant risks from CCRA3: • H8 Risks to health from vector-borne disease • H9 Risks to food safety and food security • ID9 Risk to UK public health from climate change overseas More information on the related risks can be found in CCRA technical report chapter 5, Scotland National Summary, Health and Social Care Sector Briefing.

a) Introduction

This adaptation priority covers the resilience of health systems to weather and climate sensitive pathogens. Diseases that are transmitted by insects and ticks could increase in future due to warmer temperatures and shifts in rainfall patterns changing the prevalence and distribution of these disease vectors. Climate change around the world may also affect the frequency that diseases are brought back to the UK by people travelling overseas.

Lyme disease is climate-sensitive and occurs at a higher rate in Scotland already, compared to the rest of the UK.

A particularly prevalent climate-sensitive disease in Scotland is Lyme disease, cases of which may increase with climate change due to an extended transmission season and increases in person-tick contact from increased outdoor activity. Scotland has more reported cases of Lyme disease compared to other parts of the UK, due to higher rates of outdoor tourism and higher humidity, both of which are likely to increase with climate change. The risk of new mosquito-transmitted diseases, such as dengue fever and Chikungunya is also likely to increase in Scotland, although there is no evidence indicating that mosquito transmitted diseases have yet been established.

Relevant policy in this priority area, for example on public health, is fully devolved to the Scottish Government.

b) Planning score

The consideration of a changing climate in planning for this area is scored as **low.***

- **Adaptation actions.** The strategy for reducing food-borne illness does not include climate risks, although it does mention climate change as a potential driver for future illness.

* No relevant strategies or policies relating to vector-borne diseases were found. There is a strategy for reducing food-borne illness in Scotland, published by Food Standards Scotland in 2017.

NHS National Services Scotland has undertaken an NHS Scotland-wide climate change impact assessment reviewing climate risks for each NHS board. However, these risk assessments focus on climate risks to physical assets and do not seem to include increased risks of vector-borne diseases.*

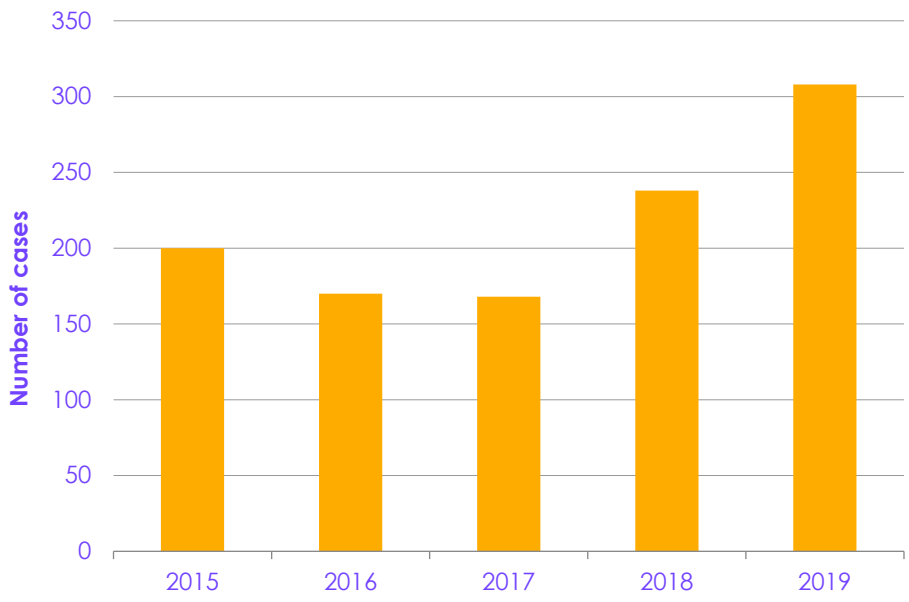
c) Risk management score

The management of climate risks within this priority area is scored as **low**. There are limited data to assess the changing risk, exposure and vulnerability of the population to pathogens. Data for Lyme disease show that incidences are increasing rapidly (Figure 3.1).

- **Lyme disease cases have increased significantly.** Laboratory confirmed cases of Lyme disease have increased in the last five years by 50% from 200 cases in 2015 to 308 cases in 2019, shown in (Figure 3.1). This is likely to be an underestimate of cases as some are treated without laboratory confirmation and will not be reflected in this dataset, and there may be cases contracted by tourists in Scotland but not diagnosed until they return home to other nations. As well as climate change, other drivers such as agriculture and land use change, shifts in tourism patterns and changes in wild animal populations may contribute to the increase in cases.

- **Food-borne illness cases have stayed the same.** Estimates of cases of food-borne illnesses (43,000 annually) by Food Standards Scotland have not changed since the previous SCCAP assessment report in 2019.

Figure 3.1 Laboratory confirmed cases of Lyme disease in Scotland



Source: Public Health Scotland (2020) *Zoonotic Disease in Scotland, 2019*

* It should be noted that during this assessment it was not possible to speak to or confirm these findings with health stakeholders due to ongoing pressures from the Covid-19 pandemic.

3. Air quality

Progress summary – Air quality
Plan score: Medium • A changing climate is considered within the latest air quality strategy and there are long-term targets for air quality in place. The Scottish Government is consulting on changes to ventilation standards to address indoor air quality. **Risk management score: Medium** • There is good evidence that respiratory diseases are remaining at stable levels but data are not available from monitoring indoor air quality.
Relevant risks from CCRA3: • H7 Risks to health and wellbeing from changes in air quality. More information on the related risks can be found in CCRA technical report chapter 5, Scotland National Summary, Health and Social Care Sector Briefing.

a) Introduction

This adaptation priority covers the health impacts of a changing climate on air quality. Weather patterns can affect the formation and dispersion of air pollutants, in particular 'blocking patterns' (particular patterns of atmospheric pressure) can lead to static and stable air masses that can cause pollutant levels to accumulate to hazardous levels. Air quality issues are divided into three areas: outdoor air quality with anthropogenic sources (traffic, heating and power generation, industry and wildfires), indoor air quality (which is dependent on building characteristics, ventilation and emissions from indoor sources), and natural sources of air quality related to pollen and mould that can affect health.

Air quality issues can be related to anthropogenic sources, for example from traffic and industry, and natural sources, such as pollen and mould.

Other effects of changes in climate on air quality are possible under significant shifts in UK weather variability but understanding of potential large-scale and local-scale circulation changes is still low. Evidence specific to Scotland is currently limited.

Relevant policy in this priority area is fully devolved to the Scottish Government, with the exception of product standards. The National Emission Ceilings Regulations (NECR) have been transposed into domestic law from EU law, following the UK's departure from the European Union. The requirements of the NECR will be implemented at UK level through a National Air Pollution Control Programme.

b) Planning score

The consideration of a changing climate in planning for this area is scored as **medium.*** Outdoor air quality is currently adequately considered in the air quality strategy. Indoor air quality is being considered under a new energy standards consultation and this score could improve if the proposed ventilation standards are adopted.

* The relevant strategy for air quality is Cleaner Air for Scotland 2 – Towards a Better Place for Everyone (2021); and the current building standards regulations (most recently revised in 2019).

Cleaner Air for Scotland 2 includes a section on climate change and how outdoor air quality may be impacted by changes in temperature.

- **Adaptation actions in plans.** The air quality strategy includes a section on climate change and how air quality will be impacted by changes in temperature, although no specific climate adaptation actions are included. Long-term targets are in place to reduce levels of air pollution to 2030. A consultation on changes to Energy Standards within Scottish building regulations proposes changes to ventilation standards to address good indoor air quality, with an intent to undertake a fuller review of ventilation provision for domestic and non-domestic buildings from 2022.

Given the relatively small role of climate change in affecting air quality, the benefits of additional adaptation to target climate induced changes in outdoor air quality are likely to be low. Further research to understand the future impact of energy efficiency measures on indoor air quality would be beneficial.

c) Risk management score

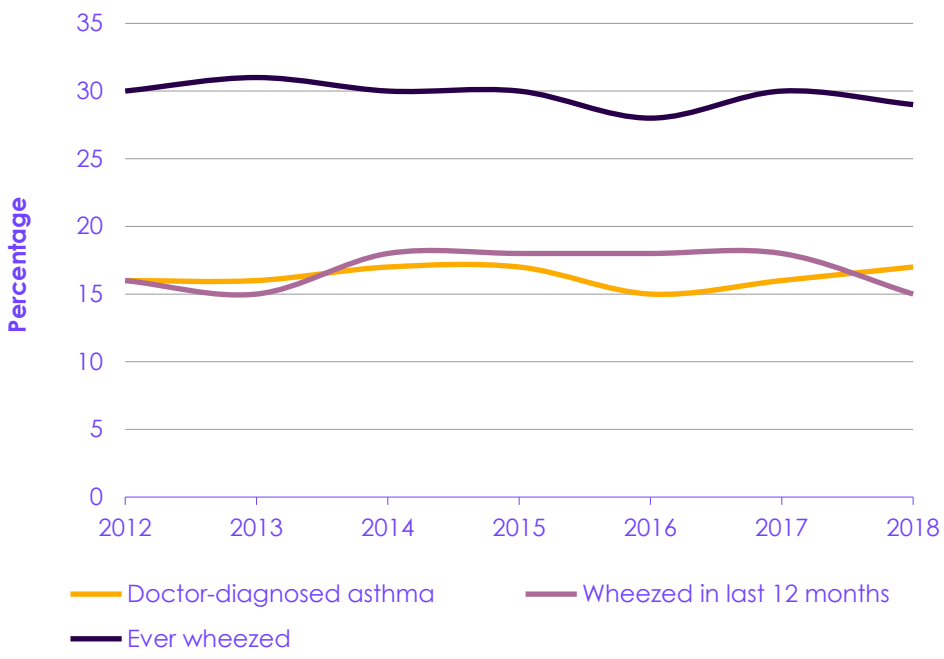
The management of climate risks within this priority area is scored as **medium**. There is good evidence that respiratory diseases are remaining at stable levels but no data available for monitoring indoor air quality.

Rates of respiratory disease such as asthma and COPD are stable in Scotland.

- **Prevalence of respiratory diseases is stable.** The prevalence of self-reported doctor diagnosed asthma among adults has remained stable at 16-17% since 2012, according to the Scottish Health Survey 2018 (revised 2020)[13], as shown in (Figure 3.2). The proportion of adults reported as having chronic obstructive pulmonary disease (COPD) has also been stable at 4% since 2008, although it was four times higher among adults living in the most deprived areas (8%) compared with those living in least deprived areas (2%).

- **There is no evidence available for monitoring of indoor air quality.**

Figure 3.2 Prevalence of self-reported doctor-diagnosed asthma



Source: Scottish Government (2020) *Scottish Health Survey 2018: main report – revised 2020*

Endnotes

[1] Kovats, S. and Brisley, R. (2021) Health, communities and the built environment. In: The Third UK Climate Change Risk Assessment Technical Report [Betts, R.A., Haward, A.B., Pearson, K.V. (eds.)]. Prepared for the Climate Change Committee, London.

[2] Met Office (2019) *UKCP18 Factsheet: Derived projections.* Available at: https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/factsheets

[3] Sniffer (2021) *Evidence for the third UK Climate Change Risk Assessment (CCRA3) Summary for Scotland.* Available at: https://www.ukclimaterisk.org/wp-content/uploads/2021/06/CCRA-Evidence-Report-Scotland-Summary-Final-1.pdf

[4] Kovats, S. and Brisley, R. (2021) *Health, communities and the built environment.* In: The Third UK Climate Change Risk Assessment Technical Report[Betts, R.A., Haward, A.B., Pearson, K.V. (eds.)]. Prepared for the Climate Change Committee, London.

[5] Scottish Government (2021) *Increased funding to tackle fuel poverty and climate change*. Available at: https://www.gov.scot/news/increased-funding-to-tackle-fuel-poverty-and-climate-change/

[6] Scottish Government (2020) *Protecting Scotland, Renewing Scotland: The Government's Programme for Scotland 2020-2021*. Available at: https://www.gov.scot/publications/protecting-scotland-renewing-scotland-governments-programme-scotland-2020-2021/documents/

[7] Scottish Government (2021) *Building regulations – energy standards and associated topics – proposed changes: consultation.* Available at: https://www.gov.scot/publications/scottish-building-regulations-proposed-changes-energy-standards-associated-topics/documents/

[8] Scottish Government (2021) *Building Standards Domestic Technical Handbook (extract) Consultation proposals – Overheating Risk.* Available online at: https://consult.gov.scot/local-government-and-communities/building-regulations-energy-standards-review/supporting_documents/Draft%20Guidance%20%20Addressing%20Overheating%20Risk%20in%20New%20Dwellings.pdf

[9] NHS Scotland (2021) *NHS Scotland Climate Emergency and Sustainability Strategy 2022-2026 Consultation Draft.* Available online at: https://www.gov.scot/publications/nhs-scotland-draft-climate-emergency-sustainability-strategy/documents/

[10] Committee on Climate Change (2019) *Final assessment: The first Scottish Climate Change Adaptation Programme*. Available at: https://www.theccc.org.uk/publication/final-assessment-of-scotlands-first-climate-change-adaptation-programme/

[11] Kovats, S. and Brisley, R. (2021) *Health, communities and the built environment.* In: The Third UK Climate Change Risk Assessment Technical Report[Betts, R.A., Haward, A.B., Pearson, K.V. (eds.)]. Prepared for the Climate Change Committee, London.

[12]Scottish Government (2019) *Scottish house condition survey*. Available online at: https://www.gov.scot/binaries/content/documents/govscot/publications/statistics/2020/12/scottish-house-condition-survey-2019-key-findings/documents/scottish-house-condition-survey-2019-key-findings/scottish-house-condition-survey-2019-key-findings/govscot%3Adocument/scottish-house-condition-survey-2019-key-findings.pdf

[13] Scottish Government (2020) *Scottish Health Survey 2018: main report – revised 2020.* Available online at: https://www.gov.scot/publications/scottish-health-survey-2018-volume-1-main-report/pages/68/

Chapter 4

Built Environment

Summary of progress

Table 4
Progress summary – Built Environment

Adaptation Priority	Plan Score	Risk Management Score
River and coastal flood alleviation	Medium	Low
Surface water flood alleviation	Low	Low
Development in flood risk areas	Low	Low
Coastal erosion risk management	Low	Low
Emergency planning and response	High	Medium
Recovery from flooding	Low	Low
Water demand in the built environment	Low	Low
Resilience of buildings to extreme weather	Low	Medium

This chapter assesses progress in adaptation of the built environment – including risks associated with flooding.

This chapter reviews progress on adapting to the weather and climate risks in the built environment. The resilience of the population to changes in temperature is discussed in Chapter 3 (Health). Flooding (coastal, fluvial and surface water) poses a significant risk to more than 150,000 people in Scotland today and the exposure to significant flooding risk is expected to increase under scenarios of both 2 degrees and 4 degrees increase in temperature.[1*] Coastal erosion now affects 46% of the soft coast in Scotland, with an overall erosion rate of 0.43 m per year.[†]

The key points from the assessment are:

- **Flood risk management plans do not include specific or measurable objectives on reducing flood risk and monitoring and evaluation is insufficient for all types of flooding.** Without clear objectives and stronger monitoring and evaluation, the next cycle of flood risk management (2022-2028) will not demonstrate avoided or reduced flood risk, despite this being one of the most severe climate risks for Scotland.

- **The draft National Planning Framework 4 (NPF4) states that development should be avoided in flood risk areas, but data are not currently collected on the number and location of new homes and other properties built in areas of flood risk.** Without collecting these data, it is not possible to assess how effective the planning framework is in restricting development in flood risk areas.

[*] Significant chance of flooding is defined as an Annual Exceedance Probability of more than 1 in 75.

[†] This equates to 8% of Scotland's total coastline.

- **The majority of Scotland's shoreline is not covered by a Shoreline Management Plan to manage coastal erosion risk.** Where plans do exist, they can be outdated and lacking up to date information that enable climate related risks to be effectively managed.

- **Good progress has been made on emergency planning and response**, with the new fire and rescue framework and a good consideration of climate change risks in strategies and plans from the Scottish Fire and Rescue Service (SFRS). SFRS are also working to collect data on wildfire incidents and response times to other incidents.

- **There is currently limited consideration of water scarcity and managing water demand in the built environment.** Private water supply owners in particular do not currently have any requirements to consider water scarcity, despite recent examples of private water supplies running dry in the summer.

- **There are multiple priority areas where previous CCC recommendations have not been acted on, resulting in low scores.** There has not been sufficient action to increase monitoring activities in relation to the number and capacity of sustainable drainage systems (SuDS) and property development in flood risk areas. Additionally, the availability of data to measure the level of risk remains limited for most of the priority areas in this chapter.

- **Whilst multiple priority areas have low plan scores, in many cases there are draft plans which could improve scores once published.** These areas include river and coastal flood alleviation, where local authorities are due to publish plans by the end of 2022; in surface water flood alleviation if the finalised NPF4 includes clear policy on surface water flooding and local flood plans are of sufficient quality; and development in flood risk areas if NPF4 includes our recommended changes which are also reflected in Local Flood Risk Management once they are published.

Recommendations for improving the quality of adaptation planning and the ability to manage the risks are set out in Table 4.1.

Table 4.1
Built Environment recommendations

Priority Area	Recommendations
River and coastal flood alleviation	The next cycle of Local Flood Risk Management Plans should identify specific and measurable objectives for reducing flood risk. Flood risk funding should be ring-fenced at the local level to ensure sufficient funds to implement Local Flood Risk Management Plans over the next six years. Reporting on Local Flood Risk Management Plans should go beyond tracking the implementation of actions and look at the extent to which objectives are being achieved, with support from SEPA.
Surface water flood alleviation	The forthcoming National Planning Framework 4 (NPF4) should commit to ensuring that new developments do not put more water into the public sewers than what was there before, taking account of climate change, and deliver SuDS that provide multiple economic, social and environmental benefits in all developments. To help improve the information on SuDS and surface water flood risk, urgently begin collecting data on sewer capacity and SuDS location, type and capacity. This would bring the level of information in line with that for river and coastal flood risk defences.

Development in flood risk areas	Data should be collected on new developments in flood risk areas and planning applications which are approved against SEPA's advice, in order to monitor local authority and SEPA objectives of avoiding future flood risk. NPF4 should include clear criteria for any essential infrastructure to be permitted in the future flood plain and place stronger requirements for flood mitigation or resilience standards on any essential infrastructure developed within the future floodplain.
Coastal erosion risk management	Scottish Government should consult on new legislation to supersede the 1949 Coastal Protection Act or to amend the Flood Risk Management (Scotland) Act 2009 to take into account the impacts of climate change on coastal erosion and for relevant local authorities, require a Shoreline Management Plan.
Emergency planning and response	Scottish Government should review the funding model for the Scottish Fire and Rescue Service, with a view to providing multi-year funding to incentivise long-term planning and preparedness for climate change.
Recovery from flooding	Scottish Government should develop national guidance for local authorities on recovery from flooding, including clear criteria for when central government funding will be made available after severe weather impacts.
Water demand in the built environment	Risk assessments for private water supplies should be amended to include consideration of current and future water scarcity.
Resilience of buildings to extreme weather	Scottish Government should include adaptation actions in the Housing to 2040 Strategy and route map to consider future increases in extreme weather, including wind and rain, to meet its aims to have houses that are fit for the future and that avoid expensive future retrofitting. Review current building standards under future climate scenarios to determine if they are sufficient to manage the risks of extreme rain and wind.
Resilience of the population to changes in temperature (Chapter 3)	Scottish Government should regulate the overheating provision as set out in the Energy Standards consultation. Expand the requirement to cover refurbishments and retrofit of existing buildings and conversions of non-domestic buildings to residential and incentivise measures for retrofitting passive cooling measures in existing homes. Scottish Government should include adaptation actions in the Housing to 2040 Strategy and route map to consider future increases in extreme weather, including overheating, to meet its aims to have houses that are fit for the future and that avoid expensive future retrofitting.

There are eight priority areas assessed in this chapter:

1. River and coastal flood alleviation
2. Surface water flood alleviation
3. Development in flood risk areas
4. Coastal erosion risk management
5. Emergency planning and response
6. Recovery from flooding
7. Water demand in the built environment
8. Resilience of buildings to extreme weather

1. River and coastal flood alleviation

Progress summary – River and coastal flood alleviation

Plan score: Medium

- SEPA's Flood Risk Management Plans consider climate change and identify objectives, although they are not specific or easily measurable. Monitoring and evaluation of the plans does not assess the effectiveness of actions taken. Local Authority flood risk management plans were due to be updated at the time of this assessment.

Risk management score: Low

- There is no evidence that actions are having an impact on the level of risk. There is new evidence that the level of risk remains high and there are pockets of flood disadvantage across Scotland.

Relevant risks from CCRA3:

- H3: Risks to people, communities and buildings from flooding.

More information on the related risks can be found in CCRA technical report chapter 5, Scotland National Summary, Flooding and Coastal Change Briefing.

a) Introduction

This adaptation priority covers risk management for river and coastal flooding. River and coastal flooding will be affected by changes to rainfall patterns, sea level rise, population growth and coastal development.

Risks from flooding are some of the most important climate risks for Scotland. Heavier rainfall, rising sea levels, and wetter winters over coming decades can raise the risk of flooding in Scotland.

Research undertaken for the Independent Assessment of UK Climate Risk (CCRA3) on flooding identified that 46,000 and 13,000 people are currently at risk of fluvial and coastal flooding respectively. This is expected to rise to 54,000 for fluvial flooding by the 2050s, under a climate scenario with a 4°C increase in global temperature.[2] Evidence from CCRA3 found that the risk of flooding to people, communities and buildings is one of the most severe risks from climate hazards for Scotland, both now and in the future.

The Scottish Environment Protection Agency (SEPA) is responsible for undertaking a National Flood Risk Assessment every six years and most recently completed one in 2018 based on UKCP09 climate scenarios. The next National Flood Risk Assessment is due in 2024. Flood Risk Management Strategies and Local Flood Risk Management Plans use the information in the National Flood Risk Assessment to set out ambition for flood risk management in Scotland and provide local detail on funding and delivery for risk management actions. The Scottish Government has committed to allocating at least £42 million per year to Local Authorities for flood risk management. In the 2020-2021 Scottish Programme for Government an extra £150 million was announced for flood risk management over the next five years and £12 million for coastal change adaptation over four years. If shared equally, this would provide an extra £6.4 million for each lead local authority on flooding.

Management of flooding risk is entirely devolved to Scotland.

Within this priority area, matters relating to flood risk management are fully devolved. Insurance and the Flood Re programme are reserved to UK level. SEPA also has a requirement to work across boundaries with the Environment Agency.

Coastal erosion is covered in the priority area Coastal Erosion Risk Management.

b) Planning score

The level of adaptation planning is scored as **medium**.* SEPA's Flood Risk Management Plans consider climate change and identify objectives, although they are not specific or easily measurable. † Monitoring and evaluation of the plans does not assess the effectiveness of actions taken. Local Authority flood risk management plans were due to be updated at the time of this assessment but had not yet been completed.

Some relevant adaptation actions are contained within SEPA's plans.

- **Adaptation actions in plans.** SEPA's Flood Risk Management Plans (2022) recognise current and future flood risks and include some proposed adaptation actions which aim to reduce river and coastal flooding, for example, scoping for a coastal flood warning scheme in Aultbea. Detailed actions are expected in the Local Flood Risk Management Plans (developed by local authorities), now due in December 2022.

- **SMART objectives.** The Flood Risk Management Plans propose actions under four broad objectives: avoid increasing flood risk; improve understanding of the flood risk; prepare for current flood risk and future flooding; reduce the risk of flooding. In each Local Distract Plan, these objectives are expanded on slightly for each 'target area', for example, 'prepare for current flood risk and future flooding as a result of climate change in Halkirk'. Neither the high-level objectives, nor the target area objectives are fully SMART as they are not sufficiently specific or easily measurable.

Current monitoring and evaluation does not adequately consider whether stated objectives have been met.

- **Monitoring and evaluation.** Local authorities publish interim reports two to three years after publication of their Local Flood Risk Management Plans under the Flood Risk Management Act (2009). A final report will also be produced at the end of the planning cycle. Interim reports from the previous planning cycle largely focused on the implementation of actions, rather than an assessment of objectives. SEPA included a section within their latest Flood Risk Management Plans which reviewed the previous plans and drew on the Local Authority interim reports, but this also did not include any assessment of how effective the plans and actions implemented were in achieving the original objectives, i.e. did the actions taken reduce overall flood risk and/or avoid an increase in flood risk? The current monitoring and evaluation process is therefore quite limited, as it does not consider whether objectives have been met.

- **Multiple climate scenarios.** The National Flood Risk Assessment (2018) considered future flood risk by looking at a 2080s future climate change scenario, based on a UKCP09 high emission scenario. The high emissions scenario is consistent with a global mean average temperature rise of more than 4°C relative to pre-industrial temperatures.

* Relevant strategies and policies relating to river and coastal flooding are: SEPA's Flood Risk Management Plans (2022); and Local Authority Flood Risk Management Plans. SEPA is also producing a Flooding Service Strategy. The strategy was consulted on in the Autumn of 2020 and is due for publication in 2022.

† SEPA publishes flood risk management plans for each of 14 Local Plan Districts. These plans were previously called strategies in the last cycle. Due to the cyber-attack on SEPA in December 2020 and the impact of the COVID-19 pandemic, the publication of SEPA's 'Flood Risk Management Plans was delayed to January 2022. SEPA are developing guidance for local authorities around monitoring of Local Flood Risk Management Plans which will be available in 2022.

c) Risk management score

The risk management score is **low.** There is no evidence that actions are having an impact on the level of risk. There is new evidence that the level of risk remains high and there are pockets of flood disadvantage across Scotland.

Funding is often identified as a barrier to implementing effective adaptation at a local level.

- **Scottish Government have met their commitment to fund local flooding schemes by at least £42 million per year, but this has not always been delivered at the local level.** Funding for flood risk management at the local level is not ring-fenced so councils can choose to reallocate these funds to deliver other priorities. In almost all of the 2019 interim reports for Local Flood Risk Management Plans, lead authorities identify funding and resource constraints as a key challenge to delivering the actions in their plans. It is likely that the Covid-19 pandemic put further pressure on local authority resources and more actions have been delayed as a result. Many of the reports shared similar paragraphs, indicating that local flood risk plans may not be fully locally 'owned' or possibly that there are challenges in allocating sufficient local staff resources to monitor progress. There are no data available on whether funding levels are sufficient to manage the risk of river and coastal flooding.

- **Interim reports in 2019 showed that the vast majority of actions in Local Flood Risk Management Plans were on track to be delivered but there is no assessment of the effectiveness of these actions on reducing flood risk.** While almost all lead local authorities identified some actions which had been delayed and would not be delivered in this cycle, these actions were consistently less than 5% of the total number. In some cases, delays were reported from local authorities responding to flood events which diverted resources away from implementing flood risk management actions. The Covid-19 pandemic is likely to have delayed the implementation of some actions as well but data were not available on this. The interim reports did not include any assessment of the extent that actions have reduced flood vulnerability and exposure.

- **A recent study found that expected annual damages from flooding (direct and indirect) is already more than £324 million per year.** Direct Expected Annual Damages for residential properties is just over £68.5 million currently. Flooding damages are expected to increase under all scenarios with the current level of adaptation.[3]

Social disadvantage is connected to flood risks in Scotland.

- **CCRA3 found that flood disadvantage is greater in coastal areas, declining urban cities and dispersed rural communities.**[4] Other pockets of flood disadvantage (areas at flood risk and the degree to which socially vulnerable groups are disproportionately affected by flooding) are found across Scotland, with Glasgow and the wider city region as one example. Social disadvantage was found to be greater on average in the devolved administrations than in England. Glasgow is one of 10 UK local authorities accounting for 50% of socially vulnerable people living in areas at flood risk.

2. Surface water flood alleviation

Progress summary – Surface Water Flood Alleviation
Plan score: low • A changing climate is not fundamentally integrated into the key policies and strategies in this area. A lack of a statutory requirement for green/multi-beneficial SuDS to manage surface water flooding in all developments remains a continued challenge. With surface water flood risk projected to increase under all scenarios there is a strong argument for greater enforcement of 'green' SuDS in all types of development. **Risk management score: low** • It is still not known how vulnerability to surface water flooding is changing. • Data on the number and capacity of SuDS installed in new developments and other drainage assets retrofitted with SuDS are not currently recorded. No action has been taken since our previous recommendation to review the monitoring and reporting arrangements for the uptake of SuDS. • Urban creep has significantly increased in Edinburgh between 1990 and 2015, increasing the risk of surface water flooding.
Relevant risks from CCRA3: • H3: Risks to people, communities and buildings from flooding. More information on the related risks can be found in CCRA technical report chapter 5, Scotland National Summary, Flooding and Coastal Change Briefing.

a) Introduction

Heavier rainfall in a warming climate can raise the risks for surface water flooding.

This adaptation priority covers an assessment of surface water flood alleviation and drainage for new and existing buildings and infrastructure. Risks of surface water flooding are affected by changing rainfall patterns, population growth and continued urban infill development.* Without adaptation, projected increases in the intensity of heavy rainfall and continued current patterns of urban development will increase the amount of surface water entering the sewerage system and is likely to lead to increased frequency of the sewerage system exceeding its capacity and increased frequency of surface water flooding when this occurs.

Research undertaken for the Independent Assessment of UK Climate Risk (CCRA3) on flooding identified that 95,000 people are currently at risk of surface water flooding in Scotland. Estimates indicate that the number of people exposed to significant surface water flooding, which is already the dominant source of flood risk in Scotland, would increase by ~ 35% over the next few decades.[5†]

Relevant policy in this priority area (planning and flood risk management) is fully devolved to the Scottish Government.

* Development of land in urban areas, usually from open-space to new construction.

† The research estimated that there are currently 42,100 residential and 10,400 non-residential properties at risk from surface water flooding (based on a 1 in 200-year event). This is projected to increase to 62,800 and 15,200 respectively by the 2080s under a 2°C scenario with low population growth, and to 89,600 and 15,500 respectively by the 2080s under a 4°C scenario with high population growth.

b) Planning score

Sustainable drainage systems are not required in all relevant developments.

The planning score for this area is **low.*** A changing climate is not fundamentally integrated into the key policies and strategies in this area. There is still no statutory requirement for green/multi-beneficial sustainable drainage systems (SuDS) to manage surface water flooding in all developments.

- **Adaptation actions in plans.**

  - The draft National Planning Framework 4 (NPF4) proposes policy on surface water flooding, although is not explicit in how this considers future flooding risk due to climate change and whether this would apply to all developments.† It states that development proposals should only be supported if they minimise the area of impermeable surface; and provide adequate drainage of surface water wherever practicable by blue and green infrastructure (such as sustainable drainage systems). The drainage requirement will include consideration of climate change and increased rainfall in line with SEPA guidance.

  - SEPA's Flood Risk Management Plans (2022) recognise current and future flood risks and include some proposed adaptation actions which aim to reduce surface water flooding. For example, a study to quantify flood risk from surface water and river sources in Strathyre. Detailed actions are expected in the Local Flood Risk Management Plans (developed by local authorities), now due in December 2022. SEPA have also committed to updating surface water flooding maps by 2028.

  - The 'Water Resilient Places' framework, published by Scottish Government, aims to improve the management of surface water flooding by complementing and supporting existing policy and organisational responsibilities as set out in the Flood Risk Management (Scotland) Act 2009.‡ The next steps are a 'delivery paper' with prioritised recommendations.

  - Regulatory Method 8 (WAT RM-08) sets out guidance on SuDS regarding the planning consultation procedure for new developments, including construction sites, buildings, roads and yards. SuDS are a legal requirement for all developments except single dwellings that drain to the water environment unless they discharge to coastal waters. However, the requirement does not appear to ensure that SuDS are multi-beneficial,§ and SEPA is only consulted for major developments (50 or more houses and industrial/business developments with a floor space that exceeds 10,000 square metres).

* Relevant strategies and policies relating to surface water flood alleviation are: SEPA's Flood Risk Management Plans (2022); Local Authority Flood Risk Management Plans; the National Planning Framework 4 (consultation draft published in 2021); Regulatory Method 8; Water Resilient Places Framework (2021).

† The draft policy states that development proposals should not be supported: within areas at risk of surface water flooding unless the risk can be successfully mitigated; where the design for surface water drainage and ground water drainage increases discharge to the public sewer network; or where the proposed drainage solution has a negative impact on the overall catchment.

‡ It includes mention of climate change but does not consider multiple warming levels, nor is there monitoring and evaluation in place.

§ When planning or specifying SuDS, early consideration of potential additional benefits can help to deliver co-benefits including improved air quality, thermal comfort in buildings, carbon sequestration and increased ecological value.

- **SMART Objectives.** SEPA's Flood Risk Management Plans (2022) propose actions under four broad objectives which are expanded on for the target areas in each Local District Plan. For example, 'reduce the risk of surface water flooding to local access roads in Strathyre'. The objectives are not fully SMART as they are not sufficiently specific (for example, in quantifying the reduction of risk) or easily measurable.

Monitoring and evaluation at local level often do not report on achievement of stated objectives.

- **Monitoring and evaluation.** Local authorities publish interim and final reports of their Local Flood Risk Management Plans. Interim reports from the previous planning cycle largely focused on the implementation of actions, rather than an assessment of objectives. The current monitoring and evaluation process is therefore quite limited, as it does not consider whether objectives have been met.

- **Multiple climate scenarios.** The National Flood Risk Assessment (2018) considered future flood risk by looking at a UKCP09 high emissions scenario in the 2080s. The high emissions scenario is consistent with a global mean average temperature rise of more than 4°C relative to pre-industrial temperatures.

Further details of adaptation actions at local level are expected in the upcoming Local Flood Risk Management Plans.

c) Risk management score

The management of climate risks within this priority area is scored as **low.**

Insufficient data exists to adequately monitor the uptake of SuDS.

- **Number and capacity of SuDS is not available.** Data on the number and capacity of SuDS installed in new developments and other drainage retrofitted with SuDS are not currently recorded. No action has been taken since our previous recommendation to review the monitoring and reporting arrangements for the uptake of SuDS. It is still not known how vulnerability to surface water flooding is changing.

- **Data on new developments in areas at risk of surface water flooding are not available.** SEPA has started work to update national surface water flood maps through a consulting project with an expectation of completing the work by 2023. This development will reflect updates in rainfall data, developments in mapping and the most up-to-date climate information (UKCP18). These maps could be compared to new development locations to better understand the rate of development in flood risk areas.

Growth in impermeable surfaces such as paving in urban settings will increase risks from surface flooding.

- **Urban creep in Edinburgh has increased**. Urban creep* has significantly increased in Edinburgh between 1990 and 2015, increasing the risk of surface water flooding.[6] Between 1990 and 2015 Edinburgh lost an average of 11.27 hectares per year of vegetated land to urban land cover (from all types of change including urban creep and urban expansion). This is equivalent to losing over fifteen football pitches of vegetated land per year. The highest rate of loss is due to urban creep from detached houses. Equivalent data are not available for all of Scotland, but it is expected that urban growth would have taken place in many other locations. Further work to include urban creep within pluvial hazard mapping would be beneficial to understand the extent of increased flood risk.

* The conversion of gardens and other vegetated areas which help to soak up rain, to built-up surfaces such as flagstones, paving, tarmac or concrete.

3. Development in flood risk areas

Progress summary – Development in flood risk areas
Plan score: Low • Current plans to restrict development in flood risk areas are insufficient but are under review. It is not possible to determine at this stage whether the updated plans will meet criteria for being good quality and lead to an increase in the planning score. **Risk management score: Low** • Relevant data on property development in flood risk areas or developments which proceed against SEPA's advice are not being collected. • The Committee has highlighted in both its previous assessments the importance of collecting these data to monitor the level of risk
Relevant risks from CCRA3: • H3: Risks to people, communities and buildings from flooding. More information on the related risks can be found in CCRA technical report chapter 5, Scotland National Summary, Flooding and Coastal Change Briefing.

a) Introduction

Development can lock-in exposure to flooding risks if climate is not incorporated into planning systems.

This adaptation priority covers development in areas at risk of river or coastal flooding. Development in current and future flood risk areas can lock-in exposure and vulnerability to flooding related impacts. SEPA have a statutory duty under the Flood Risk Management Act (2009) to provide advice when requested by planning authorities on flood risk.

Within this priority area, matters relating to flood risk management and planning are fully devolved. Insurance and the Flood Re programme are reserved to UK level.

b) Planning score

The level of adaptation planning is scored as **low.*** Plans and policies have objectives to restrict development in flood risk areas, but the objectives are not specific or measurable and there is currently not monitoring or evaluation of development in flood risk areas.

- **Adaptation actions in plans.** The National Planning Framework (NPF4), Scottish Planning Policy and Local Flood Risk Management plans are all in the process of being updated. The draft NPF4 proposes policy on flooding, stating that new development proposals in flood risk areas should be avoided and a cautious approach should be taken regarding the calculated probability of flooding. Development proposals should not be supported within the future functional floodplain unless they are: essential infrastructure where the location is required for operational reasons; for water compatible uses; redevelopment of existing buildings or sites; within a

* Relevant strategies and policies relating to the development in flood risk areas are: the National Planning Framework (NPF4); Scottish Planning Policy; SEPA's Flood Risk Management Plans (2021); SEPA's technical guidance on flood risk assessments; and Local Authority Flood Risk Management Plans.

built-up area and have an existing or committed flood protection scheme.* The requirements or criteria for allowing essential infrastructure to be built in the future flood plain are not clear in the draft NPF4. SEPA's Flood Risk Management Plans (2022) recognise current and future flood risks and include some proposed adaptation actions which aim to avoid development that increases flood risk. Detailed actions are expected in the Local Flood Risk Management Plans (developed by local authorities), now due in December 2022.

Actions in SEPAs Flood Risk Management Plans are not yet sufficiently 'SMART'.

- **SMART objectives.** SEPA's Flood Risk Management Plans propose actions under four broad objectives which are expanded on in each Local Distract Plan. The objectives are not fully SMART as they are not sufficiently specific or easily measurable.

- **Monitoring and evaluation.** Local Flood Risk Management Plans do not currently monitor and report the number and location of new properties built in areas of flood risk. SEPA is developing guidance for local authorities around monitoring of Local Flood Risk Management Plans (available in 2022).

- **Multiple climate scenarios.** The draft National Planning Framework (NPF4) references the future functional flood plain, which will be indicated by SEPA's guidance from 2019 on climate change allowances for flood risk assessment in land use planning. The guidance recommends allowances based on the UKCP09 High Emission Scenario, consistent with an average global temperature rise of more than 4°C by 2100.

c) Risk management score

The risk management score is **low.** Relevant data to assess how the risk is being managed are not currently collected. It is likely that this absence of data and monitoring itself indicates that the risk is not being managed.

There is not good data on new properties built in flood risks areas.

- **Data are not available on new properties built in flood risk areas.** Local planning authorities do not monitor and report the number and location of new homes and other properties built in areas of flood risk.

- **Planning application data are not available.** Data are not currently collected on the number of planning application decisions which are approved contrary to SEPA's advice on flood risk

- **SEPA is developing an indicator based on SEPA's flood maps and records of new development** which is expected to be published alongside the monitoring guidance in 2022.

- **Recent floods have occurred in new build properties.** In August 2021 there was a flooding incident on one street in Glasgow where 50 homes had to be evacuated.[7] The properties were built in the early 2000s, indicating that some new build homes may be at high flood risk. One resident reported being impacted by flooding eight times in the last 14 years.[8]

* The draft document defines future functional flood plain as 'The areas of land where water flows in times of flood which should be safeguarded from further development because of their function as flood water storage areas. For planning purposes the future functional floodplain will generally have a greater than 0.5% (1:200) probability of flooding by 2080'. It is unclear whether future flood risk should consider 2°C or 4°C of warming.

4. Coastal erosion risk management

Progress summary – Coastal erosion risk management
Plan score: Low • The majority of Scotland's shoreline is not covered by a Shoreline Management Plan. Where plans do exist, they may be outdated and lacking up to date information on coastal erosion risk. **Risk management score: Low** • There is insufficient evidence available on managing coastal erosion risks due to a lack of data on properties or assets damaged by coastal erosion and data on the implementation of Shoreline Management Plans.
Relevant risks from CCRA3: • H3: Risks to people, communities and buildings from flooding. • H4 Risks to viability of coastal communities from sea level rise. More information on the related risks can be found in CCRA technical report chapter 5, Scotland National Summary, Flooding and Coastal Change Briefing.

a) Introduction

Rising sea levels over coming decades creates risks for increased coastal erosion – which currently affects nearly half of Scotland's soft coastline.

This adaptation priority covers risk management for coastal erosion, sometimes called coastal change adaptation. Coastal erosion is affected by sea level rise, changes in rainfall patterns and coastal flooding. Coastal erosion now affects 46% of the erodible or soft coast in Scotland, with an overall erosion rate of 0.43 m per year. Under future climate projections, an increasing fraction of Scottish shorelines are expected to experience coastal erosion and erosion will occur at higher rates.[9] Under a high emissions scenario leading to more than a 4°C increase in global temperatures, and without further adaptation, coastal erosion is expected to affect up to 650 residential properties, 5 km of railway across 45 locations and 56 km of road across over 1000 locations.[10] While these numbers may not seem substantial, it is likely that the impacts will affect rural or remote communities more, creating an issue of climate justice if some communities lose essential connections via road and rail.

Climate impacts on coastal habitats are covered in: Marine and Coastal Habitats and Species.

Relevant policy in this priority area is devolved to Scottish Government but is currently covered by the UK 1949 Coast Protection Act. As this matter is devolved, new legislation covering coastal erosion could be introduced by the Scottish Parliament, although transboundary coordination may be required, given the connection to English coastlines. The 1949 Coast Protection Act does not require the coast to be managed sustainably or take account of climate change.

b) Planning score

Shoreline Management Plans are the main mechanism for planning coast defences in Scotland.

Shoreline Management Plans (SMPs) are the main policy mechanism for coastal defence management planning. They are developed at local level, by local authorities but are not currently a statutory requirement.

There is currently no guidance for local authorities on how to develop Shoreline Management Plans in Scotland, although guidance exists for England and is under development by Scottish Government. To date, 5 Shoreline Management Plans have been developed by local authorities in Scotland, although 24 local authorities have open coastlines.*

The majority of Scotland's coast is not covered by Shoreline Management Plans.

The level of adaptation planning is scored as **low**. There is no legislation requiring the coast to be managed sustainably and the majority of Scotland's shoreline is not covered by a Shoreline Management Plan. Where they are being developed, there is limited guidance available for local authorities to develop them. More up to date climate risk evidence has also been made available through the Dynamic Coast project since their development.

- **Adaptation actions in plans.** The 1949 Coast Protection Act does not require the coast to be managed sustainably or take account of climate change. Only five local authorities have developed Shoreline Management Plans. As they are developed by individual local authorities the plans that exist vary in content, but examples reviewed for this assessment did refer to climate change adaptation. Several of the existing shoreline management plans have not been updated recently and are therefore missing the latest evidence on coastal erosion and climate change risks.

- **SMART objectives.** Shoreline Management Plans vary in content; examples reviewed for this assessment showed specific, achievable, and relevant actions but often without timeframes.

There is no central mechanism for reviewing and assessing local Shoreline Management Plans.

- **Monitoring and evaluation.** Shoreline Management Plans are not reviewed or assessed by Scottish Government, although local authorities may have their own monitoring and evaluation processes in place.

- **Multiple climate scenarios.** Several of the current shoreline management plans have not been updated recently and are therefore missing the latest evidence on coastal erosion and climate scenarios.

Guidance is currently being produced for local authorities to develop coastal change adaptation plans which will refer to current SMP guidance in England from Defra and include relevant information on the Scottish policy and research context. This is a positive development which will support local authorities to better plan and adapt to coastal change.

In 2021, the Dynamic Coast National Overview was published, providing updated evidence on coastal erosion in Scotland since 2017. It has added significantly to the evidence base on coastal erosion in Scotland, including new analysis of social vulnerability and is a useful resource for coastal erosion planning.

c) Risk management score

The management of coastal erosion risk is scored as **low**. Updated data show coastal erosion has increased and, despite recent commitments from the Government for more funding for coastal change adaptation, there is insufficient evidence available on managing coastal erosion risks. There are no data on properties or assets damaged by coastal erosion or on the implementation of Shoreline Management Plans.

* Open coastlines are not sheltered from the sea. Some of these local authorities do not have large stretches of coast, so a Shoreline Management Plan may not be appropriate for all of them.

- **The Scottish Government confirmed £12m of funding for coastal change adaptation.** In the 2020 Programme for Government, the Scottish Government announced £12m of additional coastal change adaptation funding, from 2022, to adapt to sea level rise and protect natural coastal defences from erosion.[11]

The latest assessment indicates that coastal erosion has been observed to be increasing across Scotland.

- **The Dynamic Coast National Overview showed coastal erosion has increased and is expected to increase further in future.** The Scottish Government commissioned the Dynamic Coast National Overview to provide updated evidence on coastal change in Scotland. The assessment found that:[12]
  - Coastal erosion now affects 46% of the soft coast in Scotland, an increase from the 38% identified in 2017. The average rate of erosion is now 0.43 m per year.
  - The proportion of shorelines experiencing coastal erosion and the rate of erosion will increase under all climate change emissions scenarios.
  - Social vulnerability to coastal erosion is unevenly distributed.
  - Scotland is the only UK nation without a commitment to a fully funded coastal monitoring strategy.
- **Only five local authorities have Shoreline Management Plans and there is limited evidence available on how they have been implemented.** For the few councils which do have Shoreline Management Plans, there is no requirement for reporting on the implementation of the plans. 19 local authorities with coastlines have never developed a Shoreline Management Plan.
- **There are no data available on properties or assets damaged by coastal erosion.**

5. Emergency planning and response

Progress summary – Emergency planning and response
Plan score: High • The Scottish Fire and Rescue Service (SFRS) has a good consideration of climate change risks in its strategies and plans and has identified relevant actions to improve understanding of community risks as well. **Risk management score: Medium** • The data shows a stable trend in responding to flood incidents and a significant increase of SFRS assisting other agencies responding to non-fire incidents. It is not yet possible to extract specific data on wildfire or on response times but SFRS have committed to collecting this data in future.
Relevant risks from CCRA3: • N1 Risks to terrestrial species and habitats from changing climatic conditions and extreme events, including temperature change, water scarcity, wildfire, flooding, wind, and altered hydrology • H1 Risks to health and wellbeing from high temperatures • H3 Risks to people, communities and buildings from flooding More information on the related risks can be found in CCRA technical report chapter 5, Scotland National Summary, Health and Social Care Sector Briefing, Wildfire Briefing, High Temperature Briefing.

a) Introduction

Extreme weather events can often require responses from the emergency services to help limit their impacts.

This adaptation priority covers the role of emergency services in planning for and responding to extreme weather. Climate change could lead to increases in the frequency and intensity of extreme weather, including heatwaves, floods and wildfires, which require emergency responses. Multiple incidents can be caused by one weather event, for example severe rainfall can lead to flooding, landslides and traffic collisions.

Relevant policy in this priority area is devolved to the Scottish Government, except for maritime and coastal rescue which the UK Maritime and Coastguard Agency is responsible for. The UK Government also maintains the National Risk Register which now includes a section on climate change. British Red Cross operates in Scotland, providing emergency support to individuals and communities across the UK. The Scottish Fire and Rescue Service (SFRS) are a national organisation responsible for responding to emergency incidents including fires, floods, and road traffic collisions. Mountain rescue services are provided separately by Scottish Mountain Rescue; a charity with some Scottish Government funding.

b) Planning score

There is a high quality of adaptation planning within this priority area.

The consideration of a changing climate in planning for this area is scored as **high**.* The Scottish Fire and Rescue Service (SFRS) has a climate change response plan, a three-year strategic plan and annual corporate plans which reference increasing flood and wildfire risks affecting their operations. There is a strong accompanying performance monitoring framework as well and annual reporting to ensure they deliver appropriate actions. The consideration of climate scenarios is appropriate for the relevant timeframe for emergency planning and SFRS have committed to developing scenario planning to better understand future community risks.

- **Adaptation actions.** The SFRS Climate Change Response Plan recognises that future emergency needs will be different and that there are significant flooding and wildfire risks in Scotland. SEPA's latest flood risk management plans have committed to publishing a new flood warning development framework in 2022. The Resilient Communities Strategic Framework and Delivery Plan (2019) does not explicitly address climate change.†

The Scottish Fire and Rescue Service have clear adaptation relevant objectives and plans that are 'SMART'.

- **SMART Objectives.** The SFRS Annual Corporate Plan 2021-2022 outlines outcomes, objectives and actions to meet them, including some adaptation-relevant objectives. One of these actions is to deliver an assessment of risk and associated scenario planning based on historical and predicted data for the short, medium and long term, by 2023. This adaptation action is specific, measurable, achievable, relevant and time-bound.

There is a detailed monitoring and evaluation system in place to support delivery.

- **Monitoring and Evaluation Framework.** The SFRS reports on its performance annually and has a detailed Performance Management Framework, published in 2021, with indicators under each of its strategic outcomes. The level of data and quality of performance reporting across SFRS is commendable; the organisation has shown a clear understanding of data gaps and is working proactively to fill them.

- **Multiple climate scenarios.** The SFRS plans do not include a consideration of multiple climate scenarios but there is an action to develop an assessment of risk and scenario planning to better understand community risks by 2023.

The Fire and Rescue Framework is the statutory vehicle through which Scottish Ministers set out priorities and objectives for the Scottish Fire and Rescue Service. The current framework has been in place since 2016 and at the time of writing, consultation on a new framework was ongoing. The new draft framework includes a section on climate change, ensuring that communities are resilient and safe in response to a changing climate; mentions increased flooding, with an estimate of the number of homes currently at risk from the latest SEPA national flood risk assessment and a reference to the third Independent UK Climate Risk Assessment; and it mentions increased wildfire risks, which are not included in the current framework.

* Relevant strategies and policies relating to emergency planning and response are: the Resilient Communities Strategic Framework and Delivery Plan (2019); the Scottish Fire and Rescue Service (SFRS) Climate Change Response Plan 2045 (2020); the Scottish Fire and Rescue Service (SFRS) Strategic Plan 2019-2022 (2019); SFRS Annual Corporate Plan 2021-2022; and SEPA's Flood Risk Management Plans (2022).

† The plan aims to create "communities that are inclusive, empowered, resilient and safe". Its strategic aims include empowering communities to address any resilience issues that affect them, enabling them to take measures to "prevent, prepare for, respond to and recover from emergencies, in a way that complements the work of the emergency responders".

Even though the current Fire and Rescue Framework doesn't explicitly mention climate change, the SFRS is already planning for increased flooding and wildfires due to climate change in its Climate Change Response Plan. The new Fire and Rescue Framework would enshrine the need for the SFRS to plan for climate change in law, which will further support the SFRS plans. This priority area therefore receives a high score as SFRS have already produced a good plan preparing for climate change. Despite the long-term framework and plans, funding for SFRS is currently provided on an annual basis, making it difficult to implement long-term projects or invest in future service requirements.

c) Risk management score

The management of climate risks within this priority area is scored as **medium**. SFRS collect significant data on their response to emergency incidents and this has shown a stable trend in responding to flood incidents and an increase in assisting other agencies responding to non-fire incidents. It is not yet possible to extract robust data on wildfire, but SFRS have committed to collecting this data in future.

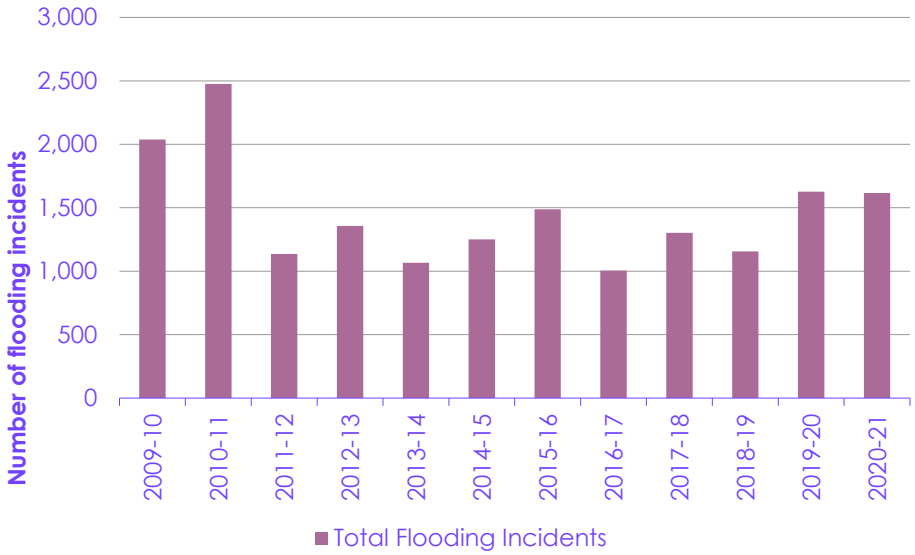
- **Flood incident attendance is stable.** The Scottish Fire and Rescue Service (SFRS) publish an annual statistical bulletin with a wide range of data which feeds into their performance reports. The number of flood incidents attended by SFRS over the last ten years (Figure 4.1) has not seen a discernible trend, despite year-to-year variations (the last two years have seen more incidents than an average year). SFRS also record the number of non-fire incidents where they assisted other agencies, and this has shown a marked increase over the last decade. Non-fire 'assist other agencies' incidents dropped slightly in the last year, likely due to COVID-19 restrictions which reduced the overall number of non-fire incidents.

Indicators for tracking wildfire related response incidents are being developed.

- **Wildfire incident data will soon be collected.** SFRS collects data on outdoor fires but not specifically on wildfire as consistently defining wildfire incidents has been a challenge. SFRS have been working with the James Hutton Institute to determine a practical definition for wildfire and update their incident reporting processes to capture wildfires, with the expectation that they will be able to begin reporting wildfire incidents from 2022.

- **Response time data is reported internally.** SFRS collect and report response times to internal management boards and committees regularly, in line with their Performance Management Framework. These data are not published as official statistics.

Figure 4.1 Flooding incidents responded to by Scottish Fire and Rescue Service



Source: SFRS (2021) *Fire and Rescue Incident Statistics 2020-2021*
https://www.firescotland.gov.uk/media/1144337/incident_statistics_2020-21.pdf

6. Recovery from flooding

Progress summary – Recovery from flooding
Plan score: Low • Local Authority Flood Risk Management plans are out of date and it is unclear whether regional and local resilience partnerships have plans which include climate change. Guidance from Ready Scot on building community resilience was published in 2019 but this is quite high level, focusing on key principles. The Scottish Flood Forum has plans to support communities, but its operations are limited by resource constraints. **Risk management score: Low** • Further evidence of long-term effects of flooding is now available, while data on homes with flood risk insurance is not available.
Relevant risks from CCRA3: • H3 Risks to people, communities and buildings from flooding More information on the related risks can be found in CCRA technical report chapter 5, Scotland National Summary, Flooding and Coastal Change Briefing.

a) Introduction

Flooding events can create several different recovery challenges.

This adaptation priority relates to recovery from flooding. Climate change is expected to increase overall rainfall levels in the winter and increase the intensity of heavy rainfall throughout the year. These changes could result in more frequent and more extreme flood events across a greater area in Scotland. Floods can cause death or injury; long term and severe mental health and wellbeing impacts; damage to property and possessions; disrupted access to employment, education and health services; and illness from water-borne pathogens or chemical contaminants. The National Flood Risk Assessment for Scotland estimates that 284,000 properties are at risk of flooding currently, and this will increase in future without sufficient adaptation action.[13] Recovery from flooding includes physical recovery of assets and services as well as recovery of socioeconomic and wellbeing impacts, such as job losses, impacts on mental health and other social disruption. Relevant policy in this priority area is devolved to the Scottish Government. The UK Government maintains the National Risk Register which now includes a section on climate change.

b) Planning score

It is difficult to assess to what extent flooding recovery planning at local level is considering climate changes.

The consideration of a changing climate in planning for this area is scored as **low**.* Regional and local resilience partnerships don't have websites where plans are published and as a result it is difficult to assess to what extent the local authorities have relevant plans which include climate change. Guidance from Ready Scot on building community resilience was published in 2019 but is quite high level.

* Relevant strategies and policies relating to recovery from flooding are: Local Authority flood risk management plans; Building Resilient Communities, Scottish Guidance on Community Resilience (2019); and the Scottish Flood Forum Business Plan and Grant Submission 2019-2022. The Scottish Flood Forum is a charity, funded by the Scottish Government with an aim to reduce the impacts of flooding on individuals and communities.

The Scottish Flood Forum has plans to support communities, but its operations are limited by resource constraints.

- **Adaptation actions.** The Scottish Flood Forum business plan includes actions to support communities and local community resilience groups to transition from recovery into resilience. Local Flood Risk Management Plans, which follow SEPA's FRM plans are due in December 2022 so were not available for this assessment. It is not clear whether regional and local resilience partnerships include climate change in local resilience plans and/or risk registers as they are not publicly available. There are also no centralised records on regional and local resilience partnerships which makes reviewing their activities challenging. The Building Resilient Communities guidance document is a framework for Scotland's emergency managers and resilience professionals working in responder organisations. It includes key principles and an approach to building community resilience. There is no national guidance for local authorities on how to provide recovery support for communities and businesses, including clear use criteria. Standing regional and local resilience partnerships meet year-round across Scotland to plan for emergencies and to take part in exercises to test those plans. The Scottish Government supports them with guidance and practical help through Resilience Partnership coordinators.

A strategy for flooding recovery could help step-forward flooding recovery planning.

Whilst it is promising that there are various initiatives related to local resilience to flooding, a cohesive strategy for recovery from flooding with specific objectives would help to improve the plan score.

The Scottish Flood Forum is funded by a grant from Scottish Government of approximately £190,000 per year. In 2020, it supported over 70 community flood groups directly and indirectly and supported the development of new groups in the Perth and Kinross and Fife council areas. Its reports already recognise that it is unable to respond to every incident and this gap between resources and need is likely to grow as flooding increases in frequency and intensity in future. In the absence of a wider Scottish Government plan for supporting recovery from flooding, the current model is likely to be unsustainable.

c) Risk management score

The management of climate risks within this priority area is scored as **low**. Further evidence of long-term effects of flooding is now available, while data on homes with flood risk insurance is not available.

Flooding events in Scotland have been demonstrated to have wide ranging impacts.

- **Flooding has been shown to affect mental health in Scotland.** A recent three-year study of flood affected communities in Scotland identified mental health impacts resulting from long-term use of temporary accommodation, and sustained involvement in the refurbishment of their properties. Further upset and anxiety arose from frequent communications with insurance companies and dealing with unforeseen costs.[14]

- **Flooding has wider community impacts.** The same study found that flooding affected the entire community; people whose homes or businesses were not flooded were still affected by disruption to utilities, transport infrastructure and local services. Flooding has a serious financial impact on many local businesses.

- **Data on homes with flood risk insurance is not available.** Flood Re, a joint initiative between the Government and insurers, has allowed at-risk homes built before 2009 to be insurable. However, there is no data on how many homes have insurance that covers flood risk.

- **Further research and data collection are still required to understand the scale of the risk in terms of recovery time.** The time it takes to recover from flooding is based on several complex factors, including the depth of the flood water and duration of the flood; how contaminated the flood water is; the length of time to dry out a property; having financial assistance through grants and insurance; having access to social support networks; and the long-term strategies to return people to their homes and manage (physical and mental) health impacts.

7. Water demand in the built environment

Progress summary – Water demand in the built environment
Plan score: Low • There is limited consideration of water scarcity and managing water demand within current plans. **Risk management score: Low** • New evidence has found that many private water supplies are at high risk in future climate scenarios and household water consumption is not being monitored over time.
Relevant risks from CCRA3: • I8 Risks to public water supplies from reduced water availability • H10 Risks to water quality and household water supply More information on the related risks can be found in CCRA technical report chapter 5, Scotland National Summary.

a) Introduction

Changing climate conditions will raise the risk of water supply-demand deficits in some parts of Scotland.

This adaptation priority covers water demand in the built environment, excluding industry. The latest projections of future water availability for CCRA3 show that without additional adaptation actions, some water resource zones in Scotland will be in supply-demand deficit by the mid-century, under both 2°C and 4°C warming scenarios (assuming a central estimate of future population growth), and an increasing number will be in deficit by the late century.* Very low river and spring flows and low reservoir and loch levels have occurred during the past century in both West and East Scotland in after prolonged periods of dry weather.[15] Though Scotland is projected to have an overall supply-demand balance surplus, transfers of water between surplus and deficit areas are likely to be prohibitively expensive or impossible due to challenging terrain in many cases. Reducing the demand for water is therefore an important area of adaptation.

Private water supplies are more common in Scotland than the rest of the UK and create additional adaptation challenges.

Private water supplies are more common in Scotland than in other parts of the UK, presenting different challenges for adaptation. There are over 21,000 private water supplies in Scotland, supplying approximately 180,000 people or about 3% of the population, originating from sources such as lochs, burns or boreholes.[16]

Water supply is also discussed in Water demand by industry and Public water supply infrastructure.

Relevant policy in this priority area is fully devolved to the Scottish Government, except for product efficiency labelling.

* When the balance between the demand for water and available supplies is insufficient to maintain an acceptable reliability of supply to customers. Acceptable reliability of supply is defined in terms of the ability to satisfy specified levels of service relating to the frequency and severity of shortages.

b) Planning score

There is currently limited consideration of future climate risks in current planning for this priority area.

The consideration of a changing climate in planning for this area is scored as **low**.* There is limited consideration of water scarcity and managing water demand within current plans. Objectives in relevant plans are not SMART and there is limited monitoring and evaluation for reducing water demand.

- **Adaptation actions in plans.** While there are no specific adaptation actions set out in Scottish Water's Strategic Plan (2020), it recognises the climate crisis as Scottish Water's biggest challenge, with adapting to climate change part of the three strategic outcomes. SEPA's Water Supply and Wastewater Sector plan includes actions to help communities to prevent water being wasted and to use it more efficiently; and to make low water use designs, including designs involving recycled water and rainwater, the norm for new developments. The National Water Scarcity Plan (2020) references drier summers in the future from climate change and includes an action from Scottish Water to work with their customers to encourage water saving measures. The plan also includes water scarcity alert levels and a hierarchy of actions in response.

  Under current regulations, small non-commercial private water supplies must be registered by the local council but don't have to be risk assessed or tested, unless a grant is being requested from the Scottish Government. 82% of private water supplies fall under this category.[17] For private water supplies that supply 50 or more people or more than 10 m^3 per day (for example for tourism sites) or are used in other commercial or public activity, a risk assessment and safety testing is required. The risk assessment currently has limited consideration of water scarcity. By comparison, in England risk assessments must be done for all private water supplies, regardless of their size.

- **SMART objectives.** Scottish Water's statutory objectives for 2021-2027 (set by the Scottish Government) include identifying the impacts of climate change on its assets, and preparing and implementing plans for adaption measures necessary to protect its services.[18] While these objectives are measurable, they do not require an assessment of the effectiveness of actions. SEPA's Water Supply and Wastewater Sector plan includes an outcome that 'water supplies are not being wasted', 'people understand the value of water and seek to avoid wasting it' and 'homes and business premises are designed so that achieving low drinking water use requires no extra effort'. The plan does not include timelines for actions and objectives are not easily measurable.

- **Monitoring and evaluation.** Scottish Water reports annually on its performance, although for water demand this only includes reporting on the number of water saving packs distributed to households. The Water Supply and Wastewater Sector plan does not include any plans for monitoring and evaluation.

* Relevant strategies and policies relating to water demand in the built environment are: Scottish Water's statutory objectives for 2021-2027 (set by the Scottish Government); Scottish Water's 25-year Water Resources Management Plan (2015); the Water Intended for Human Consumption (Private Supplies) (Scotland) Regulations 2017; SEPA's National Water Scarcity Plan (2020); and SEPA's Water Supply and Wastewater Sector Plan.

Plans currently in development could raise the plan score in the future.

- **Multiple climate scenarios.** The 25-year Water Resources Management Plan (2015) includes a vulnerability assessment of water availability based on the UKCP09 climate projections for the UK.[19] Scottish Water are currently developing a climate change risk assessment for the 2021-27 period, exploring the potential impacts of 2°C and 4°C global warming scenarios on water supply infrastructure to the end of this century, and designing an adaptation plan to address these. This is expected in 12 to 18 months and could increase the planning score in future depending on the contents.

c) Risk management score

The management of climate risks within this priority area is scored as **low**. New evidence has found that many private water supplies are at high risk in future climate scenarios, household water consumption is not being monitored over time and in the last two summers areas of Scotland have been at moderate or significant scarcity of water.

- **Household water consumption levels are included in annual reports but the effectiveness of interventions is not monitored over time to manage risks.** Scottish Water report annually on their performance across a range of objectives and indicators but data on household water consumption, and progress to manage risks, is not monitored and assessed over time to ensure it is reducing.

- **Water saving packs have been distributed to homes across the country.** In total 56,826 water savings packs have been distributed to homes, included 13, 252 in the reporting year (2020-2021).[20] The packs include information on how to save water in the household and a range of water devices, such as a tap aerator to reduce water use. Given the range of advice included in the packs and the uncertainty around the extent to which the advice is followed, it is difficult to assess the impact of the water saving packs.

There are high risks to many private water supplies in Scotland.

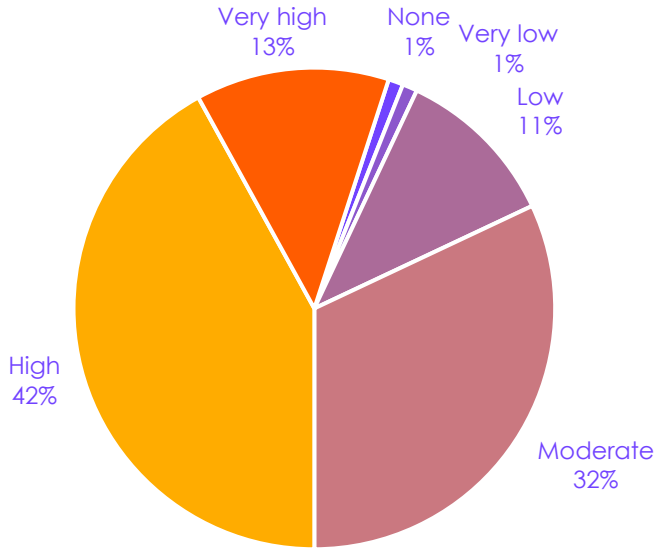
- **A recent study looking at climate impacts on private water supplies found that almost half of private water supplies in Scotland are estimated to be in areas of high or very high risk** (Figure 4.2). [21] The north-east of Scotland is at higher risk due to projected changes in precipitation and high numbers of private water supplies. In other areas of upland Scotland private water supplies may be at risk as well. Analysis of 2018 data also found that the climate contributed to the large number of requests for support for private water supplies, provided through bottled water or water in tankers.

In recent years there have been periods of raised water scarcity risk in parts of Scotland.

- **SEPA raised water scarcity alerts for several areas of Scotland in the summers of 2020 and 2021.** SEPA publishes water scarcity situation reports as needed during summer months. In July 2020, SEPA reported that north-east Scotland was at 'moderate scarcity' and most of the rest of the east of Scotland was on alert. [22] In July and August 2021, Wigtownshire and Wick areas were moved to 'significant scarcity' and other areas were classified as 'moderate scarcity' (see Figure 4.3).[23]

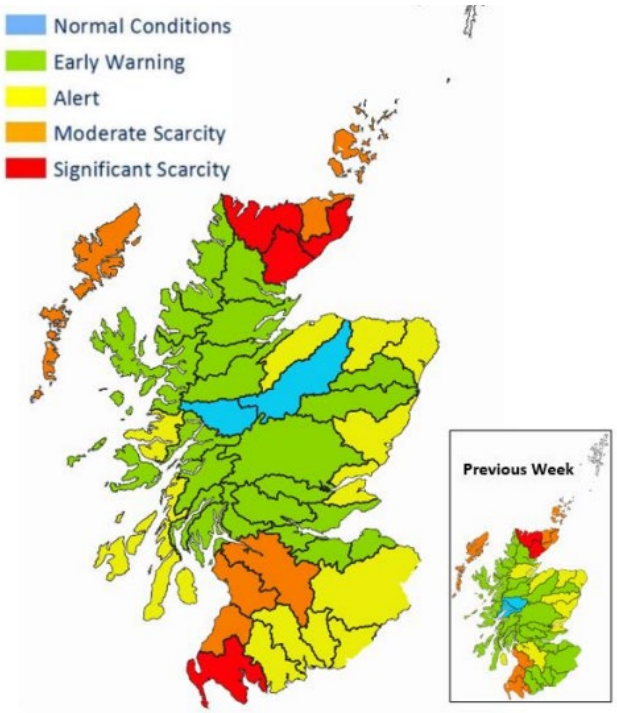
- **In the summer of 2021, the Scottish Government launched a support scheme offering free bottled water to people with reduced private water supplies.[24]** Local Authorities were provided with an emergency funding scheme to supply bottled water to domestic households where their private water supply had run dry.

Figure 4.2 Proportions of private water supplies in Scotland per Meteorological Drought Risk Indicator category between 2020 and 2050



Source: CREW (2020) *Private Water Supplies and Climate Change.*

Figure 4.3 Overall risk of water scarcity 29th July 2021



Source: SEPA (2021) *Water Situation Report*
Notes: Overall risk of water scarcity considers individual water scarcity indices, relevant water use sectors in each region and forecast weather conditions

8. Resilience of buildings to extreme weather

Progress summary – Resilience of buildings to extreme weather
Plan score: Low • The new Housing to 2040 Strategy does not include any climate adaptation measures, undermining its aims to ensure houses are fit for the future. Current building standards do not consider future climate change scenarios. The draft Heat in Buildings strategy does not explicitly include climate change adaptation. **Risk management score: Medium** • Indicators on housing condition have shown stable or slight positive trends. However, as the building standards may not be fit for future changes in the climate, it is not clear that the risk is being managed.
Relevant risks from CCRA3: • H5: Risks to building fabric More information on the related risks can be found in CCRA technical report chapter 5, Scotland National Summary, Housing Sector Briefing.

a) Introduction

This adaptation priority area covers resilience of buildings to extreme weather such as extreme winds and rain.

This adaptation priority covers the resilience of buildings to weather conditions. Extreme winds and rain can damage buildings, and persistent adverse weather conditions can lead to damage from moisture and subsidence. The latest Independent Assessment of UK Climate Risk (CCRA3) found exposure to wind-driven rain in Scotland currently ranges from 'very severe' along much of the west coast and Scottish islands to 'moderate' in some east coast areas.* Relevant policy in this priority area (planning and building regulations) is fully devolved to the Scottish Government.

b) Planning score

Good adaptation planning in this area exists, but only covers a small fraction of buildings.

The consideration of a changing climate in planning for this area is scored as **low**.† A changing climate is not integrated into the key policies and strategies in this area. While Historic Environment Scotland has published a good adaptation plan this is insufficient to improve the planning score across all buildings in Scotland.

- **Adaptation actions in plans.** The Housing to 2040 Strategy and the Draft Heat in Buildings Strategy do not include any objectives relating to climate change adaptation. This creates a lock-in risk as new homes built today are not made resilient to future weather conditions without further and potentially costly retrofitting. Building standards regulations represent minimum requirements to ensure buildings are safe, efficient and sustainable but do not currently consider future changes to the climate.

* The impacts of high and low temperatures are not covered here and are instead covered in the priority area: *Resilience of the Population to Changes in Temperature* in Chapter 3.

† Relevant strategies and policies relating to the resilience of building to extreme weather are: the Heat in Buildings Strategy (2021); Housing to 2040 Strategy (2021); Tolerable Standards and Scottish Housing Quality Standards; the current building standards regulations (most recently revised in 2019); and Climate Ready Historic Environment Scotland (2021).

In 2021, Historic Environment Scotland (HES) published its first climate change adaptation plan. The plan uses Adaptation's Scotland's Capability Framework and is informed by a climate risk assessment for the organisation. It includes specific adaptation actions to respond to the climate risks identified.

- **SMART objectives.** Climate Ready Historic Environment Scotland (2021) includes SMART objectives across the different climate risks identified. The actions will take place across more than 300 properties of national importance which HES is responsible for.[25]

- **Monitoring and evaluation.** Climate Ready Historic Environment Scotland (2021) has a section on monitoring progress over the next five years.

c) Risk management score

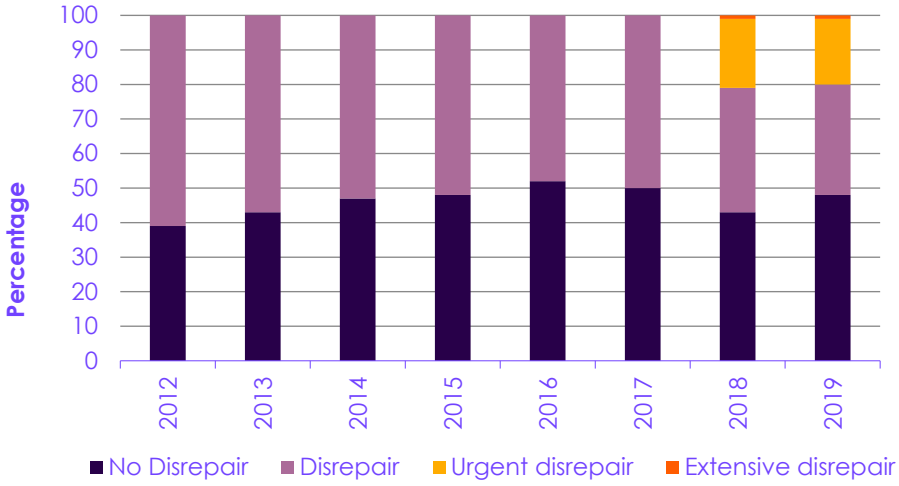
The management of climate risks within this priority area is scored as **medium**. There is some evidence of an improvement in housing stock condition, but limited evidence regarding the preparedness of the housing stock for the future climate.

There has been some improvement in the housing stock condition over the last decade.

- **Current housing stock condition has improved.** The fraction of housing in good condition is indicative of the current ability of the housing stock to withstand weather and climate extremes. Latest survey data shows some improvements in housing stock quality. The Scottish Housing Quality Survey in 2019 found only 2% of all dwellings fell below the Tolerable Standard and showed a long-term improvement since 2012 (Figure 4.4).

- **Adequacy of housing stock for future weather conditions is unknown.** There is limited information available regarding the adequacy of newly built and current housing for future climates. Current building standards have not been designed to take account of possible future climate conditions. This means it is currently impossible to determine the fraction of newly built homes that are appropriately designed to withstand expected future climates from data on compliance with building standards.

Figure 4.4 Disrepair to Critical Elements in housing stock, 2012-2019



Source: Scottish Government (2019) *Scottish house condition survey: 2019 key findings.*
Notes: From 2014-2017 data on urgent disrepair and extensive disrepair was not available so disrepair includes these categories.

Endnotes

[1] Sayers, PB., Horritt, M, Carr, S, Kay, A, Mauz, J., Lamb R, and Penning-Rowsell E (2020) Third UK Climate Change Risk Assessment (CCRA3): Future flood risk. Research undertaken by Sayers and Partners for the Committee on Climate Change. Published by Committee on Climate Change, London

[2] Sayers, PB., Horritt, M, Carr, S, Kay, A, Mauz, J., Lamb R, and Penning-Rowsell E (2020) Third UK Climate Change Risk Assessment (CCRA3): Future flood risk. Research undertaken by Sayers and Partners for the Committee on Climate Change. Published by Committee on Climate Change, London

[3] Sayers, PB., Horritt, M, Carr, S, Kay, A, Mauz, J., Lamb R, and Penning-Rowsell E (2020) Third UK Climate Change Risk Assessment (CCRA3): Future flood risk. Research undertaken by Sayers and Partners for the Committee on Climate Change. Published by Committee on Climate Change, London Available online at: https://www.ukclimaterisk.org/wp-content/uploads/2020/07/Future-Flooding-Main-Report-Sayers-1.pdf

[4] Sayers, PB., Horritt, M, Carr, S, Kay, A, Mauz, J., Lamb R, and Penning-Rowsell E (2020) Third UK Climate Change Risk Assessment (CCRA3): Future flood risk. Research undertaken by Sayers and Partners for the Committee on Climate Change. Published by Committee on Climate Change, London Available online at: https://www.ukclimaterisk.org/wp-content/uploads/2020/07/Future-Flooding-Main-Report-Sayers-1.pdf

[5] Sayers, PB., Horritt, M, Carr, S, Kay, A, Mauz, J., Lamb R, and Penning-Rowsell E (2020) Third UK Climate Change Risk Assessment (CCRA3): Future flood risk. Research undertaken by Sayers and Partners for the Committee on Climate Change. Published by Committee on Climate Change, London Available online at: https://www.ukclimaterisk.org/wp-content/uploads/2020/07/Future-Flooding-Main-Report-Sayers-1.pdf

[6] Rowland, C. et al, Centre of Expertise for Waters (CREW), 2016, *Quantifying rates of urban creep in Scotland: results for Eindburhg between 1990, 2005 and 2015.* Available online at: https://www.crew.ac.uk/sites/www.crew.ac.uk/files/publication/CRW2016_16_Urban_Creep_Main_Report.pdf

[7] Easton, K. and Ferguson, L. *Drumpchapel residents evacuated after major flooding leaves people trapped in homes*, Glasgow Live, 10/08/2021. Available online at: https://www.glasgowlive.co.uk/news/glasgow-news/drumchapel-residents-evacuated-after-major-21270648

[8] Vesty, S. *Glasgow family homeless after house destroyed by flood for 8th time in 14 years*, Glasgow Live, 29/08/2021. Available online at: https://www.glasgowlive.co.uk/news/glasgow-news/glasgow-family-homeless-after-house-21430709

[9] A.F. Rennie, J.D. Hansom, M.D. Hurst, F.M.E Muir, L.A. Naylor, R.A. Dunkley, & C.J. MacDonell (2021). Dynamic Coast: The National Overview (2021). CRW2017_08. Scotland's Centre of Expertise for Waters (CREW). Available online at: crew.ac.uk/publications

[10] : F.M.E Muir, M.D. Hurst, A.F. Rennie & J.D. Hansom (2021). Dynamic Coast: National Coastal Erosion Risk Assessment. CRW2017_08. Scotland's Centre of Expertise for Waters (CREW). Available online at: crew.ac.uk/publications

[11] Scottish Government (2020). *Protecting Scotland, Renewing Scotland: The Government's Programme for Scotland 2020-2021*

[12] A.F. Rennie, J.D. Hansom, M.D. Hurst, F.M.E Muir, L.A. Naylor, R.A. Dunkley, & C.J. MacDonell (2021). Dynamic Coast: The National Overview (2021). CRW2017_08. Scotland's Centre of Expertise for Waters (CREW). Available online at: crew.ac.uk/publications

[13] SEPA (2018) *National Flood Risk Assessment*.

[14] M. Currie, L. Philip & G. Dowds (2020). Long-term impacts of flooding following the winter 2015/16 flooding in North East Scotland: Summary Report. CRW2016_02. Scotland's Centre of Expertise for Waters (CREW)

[15] M.Rivington, I. Akoumianaki and M. Coull (2020). Private Water Supplies and Climate Change The likely impacts of climate change (amount, frequency and distribution of precipitation), and the resilience of private water supplies. CRW2018_05. Scotland's Centre of Expertise for Waters (CREW).

[16] Drinking Water Quality Regulator for Scotland (2021), *Drinking Water Quality in Scotland 2020 Private Water Supplies.* Available online at: https://dwqr.scot/media/2q4etvrh/pws-annual-report-2020-final.pdf

[17] Drinking Water Quality Regulator for Scotland (2021), *Drinking Water Quality in Scotland 2020 Private Water Supplies.* Available online at: https://dwqr.scot/media/2q4etvrh/pws-annual-report-2020-final.pdf

[18] Scottish Government (2020). *Scottish Water: directions 2020*: https://www.gov.scot/publications/scottish-water-directions-2020/.

[19] Scottish Water (2015). *Water Resource Plan 2015 (Summary Report)*.

[20] Scottish Water (2021), *Annual report & accounts 2020/2021: Performance and Prospects*.

[21] M.Rivington, I. Akoumianaki and M. Coull (2020). Private Water Supplies and Climate Change The likely impacts of climate change (amount, frequency and distribution of precipitation), and the resilience of private water supplies. CRW2018_05. Scotland's Centre of Expertise for Waters (CREW).

[22] SEPA (2020) *Water Situation Report.* Available online at: https://www.sepa.org.uk/media/514856/water-scarcity-situation-report-16-july-2020.pdf

[23] SEPA (2021) *Water Situation Report.* Available online at: https://www.sepa.org.uk/media/587491/210729-official-business-water-situation-report.pdf

[24] Scottish Government (2021) *Water Shortages Support*. https://www.gov.scot/news/water-shortages-support/

[25] Historic Environment Scotland website: https://www.historicenvironment.scot/about-us/who-we-are/about-historic-environment-scotland/

Chapter 5

Infrastructure

Table 5
Progress summary - Infrastructure

Adaptation Priority	Plan Score	Risk Management Score
Energy generation, transmission and distribution	Medium	Low
Public water supply infrastructure	Low	Medium
Airports	Low	Low
Ports and ferries	Low	Low
Rail network	High	Medium
Road network	Medium	Low
Telecoms, digital and ICT infrastructure	Low	Low
Design and location of new infrastructure	Medium	Low
Infrastructure interdependencies	Low	Low

This chapter assesses progress in adapting infrastructure to climate change across Scotland.

This chapter considers progress in adapting infrastructure to climate change.* Extreme weather from a changing climate can cause disruption to and failure of infrastructure systems, with significant and long-lasting effects on people and the economy. Climate and weather-related disruption of infrastructure could also affect the Scottish Government's plans to reach Net Zero, for example, as increased reliance on electricity magnifies the consequences of power outages and makes cascade failures to other networks more probable.

Some parts of infrastructure policy remain reserved to the UK Government, meaning responding to climate risks can be complex. However, impacts of weather-related disruption to infrastructure will be felt at local level meaning the Scottish Government still needs to have effective plans in place to deal with these events.

The key points from the assessment are:

- **The Scottish Government currently do not have any policy documents considering adaptation or resilience of energy networks.** Although policy for energy is reserved to the UK Government, the Scottish Government hold clear policy positions and have published plans for reserved areas relating to greenhouse gas emissions reductions, for example in its Energy Strategy, but not for adaption.

* Infrastructure is referred to as 'supporting systems' in SCCAP2.

Risks to people and the economy from climate-related failure of the power system was highlighted by the Committee as one of eight risk areas that require the most urgent attention in the next two years, in the most recent Independent Assessment of UK Climate Risk.

- **Progress has been made to prepare roads and the rail network for climate change**. Transport Scotland has several relevant plans and policies which reference adaptation and it is in the process of developing a new adaptation strategy.

- **There is a lack of plans and policies for managing climate risks to telecoms, digital and ICT infrastructure.** The Committee has highlighted this gap in its previous SCCAP assessments but no further progress has been made. While telecoms policy is reserved to the UK Government, the Scottish Government recently published a digital strategy with no mention of climate risks. The importance of the resilience of digital infrastructure has also been highlighted by the Covid-19 pandemic.

- **There is no national assessment of the scale of risk of cascading infrastructure failures due to interdependencies in Scotland and no plans in place to address the risk.** Risks to infrastructure networks from cascading failures are one of the most urgent risks identified in the Independent Assessment of UK Climate Risk (CCRA3). Storm Arwen in 2021 highlighted the potential for cascading risks, as 40,000 customers were left without power; water supplies were affected; schools closed; and travel disruption was widespread.

- **Availability of data to assess the level of risk remains limited for most of the priority areas in this chapter, resulting in mostly low scores for risk management.**

Recommendations for improving the quality of adaptation planning and the ability to manage the risks are set out in Table 5.1.

Table 5.1
Infrastructure recommendations

Priority Area	Recommendations
Energy generation, transmission and distribution	Urgently include adaptation and increased resilience to climate risks as a key priority in the upcoming Energy Strategy. Identify actions which can be taken within Scotland and to influence UK Government policy which would respond to the multiple climate risks affecting energy generation, transmission and distribution in Scotland.
Public water supply infrastructure	Scottish Water leakage targets should be determined with consideration of potential climate change risks to future water availability, rather than just on the basis of economic measures.
Airports	The Islands Connectivity Plan (ICP) should include a consideration of climate risks and specific adaptation actions for the next planning period, in line with the National Islands Plan transport resilience objective The Transport Scotland adaptation strategy should include specific adaptation objectives to meet the priority in the Transport Strategy 2 on climate action and the aim to ensure the transport system is adapted to projected climate change impacts

Ports and ferries	The Islands Connectivity Plan (ICP) should include a consideration of climate risks and specific adaptation actions for the next planning period, in line with the National Islands Plan transport resilience objective Where there are insufficient data on the impacts of climate change on ports and ferries in Scotland, Transport Scotland should commission research to fill these gaps The Transport Scotland adaptation strategy should include specific adaptation objectives to meet the priority in the Transport Strategy 2 on climate action and the aim to ensure the transport system is adapted to projected climate change impacts
Road network	The Transport Scotland adaptation strategy should include specific adaptation objectives to meet the priority in the Transport Strategy 2 on climate action and the aim to ensure the transport system is adapted to projected climate change impacts
Telecoms, digital and ICT infrastructure	In the digital strategy, include actions which can be taken within Scotland and to influence UK Government policy which would respond to the multiple climate risks affecting digital infrastructure in Scotland.
Design and location of new infrastructure	NPF4 should include explicit reference to the *location* of new infrastructure to consider future climate change impacts The Monitoring programme for the upcoming NPF4 should include collection of evidence on whether new infrastructure assets are designed and located with appropriate consideration of climate change impacts.
Infrastructure interdependencies	Specific policies and/or actions in the SCCAP to plan for, and manage, risks from interdependent infrastructure. National level planning for interdependency risks, applying lessons and approaches from regional programmes such as Climate Ready Clyde. Policy leads should encourage greater engagement from key Scottish infrastructure operators in the Infrastructure Operators Adaptation Forum (IOAF), particularly in sectors which have made limited progress on adaptation.

There are nine priority areas assessed in this chapter:

1. Energy generation, transmission and distribution
2. Public water supply infrastructure
3. Airports
4. Ports and ferries
5. Rail network
6. Road network
7. Telecoms, digital and ICT infrastructure
8. Design and location of new infrastructure
9. Infrastructure interdependencies

1. Energy generation, transmission and distribution

Progress summary – Energy generation, transmission and distribution
Plan score: Medium • Electricity transmission and distribution companies and gas network operators have submitted updated adaptation plans under the third round of Adaptation Reporting Power (ARP3). A summary report is available for the generation sector. • Current and upcoming Scottish Government policy documents do not consider adaptation or resilience of energy networks. **Risk management score: Low** • Indicators are not available for Scotland.
Relevant risks from CCRA3: • I1 Risks to infrastructure networks (water, energy, transport, ICT) from cascading failures • I2 Risks to infrastructure services from river, surface water and groundwater flooding • I3 Risks to infrastructure services from coastal flooding and erosion • I6 Risks to hydroelectric generation from low or high river flows • I7 Risks to subterranean and surface infrastructure from subsidence • I9 Risks to energy generation from reduced water availability • I10 Risks to energy from high and low temperatures, high winds, lightning • I11 Risks to offshore infrastructure from storms and high waves More information on the related risks can be found in CCRA technical report chapter 4, Scotland National Summary, Energy Sector Briefing.

a) Introduction

This priority area covers the climate and weather resilience of energy networks.

This adaptation priority covers the resilience of energy networks which includes production, transmission and distribution of electricity and gas. Energy infrastructure is affected by numerous weather and climate hazards, including changing frequency and intensity of surface water and coastal flooding. Extreme high and low temperatures, high winds, snow, ice and lightning can all cause disruption to the energy network as can wind droughts as the first half of 2021 demonstrated. There are also risks to buried infrastructure, such as gas pipelines, becoming damaged from flooding and subsidence as a result of severe climatic conditions such as rainfall and drought. Hydroelectric power output can also be affected by high and low river flows which may change due to altering rainfall patterns.

Recent storms have highlighted the impact that extreme weather can have on Scottish energy networks.

Scotland has recently seen a number of extreme weather events which impacted energy services, for example Storms Ciara and Denis in 2020, and Storm Arwen in November 2021(Box 5.1). Currently, 34 electricity substations are exposed to significant* surface water flooding and 33 are exposed to significant river flooding. The latest Independent Assessment of UK Climate Risk (CCRA3) found risks to electricity assets from surface water flooding are projected to increase under future climate scenarios, at the same time as the transition to Net Zero and

* Significant chance of flooding is defined as an Annual Exceedance Probability of more than 1/75

continued digitalisation across the economy will create a much larger electricity system that is more dependent on weather (particularly offshore wind) for its functioning.[1] This implies a much greater exposure to impacts if systemic failures due to weather incidents occur.

Climate impacts which cascade across different types of infrastructure are covered in the priority area: Infrastructure Interdependencies and issues related to infrastructure planning are covered in the priority area: Design and Location of New Infrastructure.

Relevant policy is a mixture of reserved and devolved responsibility.

Relevant policy in this priority area is largely reserved, except for energy efficiency. However, the Scottish Government works closely with the UK Government, and with electricity network operators and owners, and emergency response to electricity system failures is largely devolved in practice.

b) Planning score

Adaptation planning in this priority area is scored as medium.

The consideration of a changing climate in planning for this area is scored as **medium**.* Electricity transmission and distribution companies and gas network operators have submitted updated climate risk assessments and adaptation plans under the third round of Adaptation Reporting Power (ARP3). Energy UK has submitted a sector report on behalf of generators. The sectoral report for electricity generators does not include adaptation plans. The single policy mentioned within SCCAP2 and the upcoming energy strategy does not directly address adaptation considerations.

- **Adaptation actions in plans.** The Vision for Scotland's Electricity and Gas Networks (2019) does not currently include any explicit references to adaptation. It does mention the resilience of the energy system, but not in relation to weather and climate risks. The Energy Strategy Position Statement (2021) does not mention weather and climate resilience or adaptation. ARP3 reports present planned adaptation measures for electricity transmission & distribution companies and gas network operators. The sectoral report for UK electricity generators does not provide detailed risk assessments or adaptation plans for individual generators in Scotland.

- **SMART objectives.** Adaptation objectives are broadly presented for the electricity transmission & distribution companies and gas network operators in the ARP3 reports.

- **Monitoring and evaluation.** Monitoring and evaluation is summarised to varying degrees across the ARP3 reports for electricity transmission & distribution companies and gas network operators.

- **Multiple climate scenarios.** The latest ARP3 reports show that electricity transmission and distribution companies and gas network operators in Scotland are largely assessing their climate risks for a range of climate scenarios broadly consistent with 2ºC and 4ºC warming above preindustrial levels. The Energy UK ARP3 report for generators indicates that an evaluation of climate impacts on generators using UKCP18 climate projections has been completed, though a detailed risk assessment is not presented in the report.

* SCCAP2 includes the Vision for Scotland's Electricity and Gas Networks (2019) as a key energy adaptation policy. Scottish Government has also published an Energy Strategy Position Statement (2021).

While energy policy is largely reserved, the Scottish Government have published a vision for electricity and gas and are currently drafting an energy strategy. These strategies could be expanded to include multiple climate risks affecting the energy network. The current energy strategy position statement also includes actions aiming to influence reserved UK Government policy; a similar approach could be taken towards reserved energy resilience issues.

Storm Arwen demonstrated the potential disruption that extreme weather can cause to energy supply.

Box 5.1
Impacts of Storm Arwen on energy networks

Storm Arwen, on 26 November 2021, caused extensive and unprecedented damage to the Scottish electricity network, initially leaving 40,000 customers without power and at least 17,000 homes without power for four nights. Water supplies were affected, schools closed and travel disruption was widespread. Much of the damage was caused by wind gusts of over 100mph blowing over trees and damaging power infrastructure. Over 500 points of system failure were recorded; the previous high from a single weather event was 150. Power companies have attributed the severity of the damage to the direction of the wind gusts as the winds were northerly rather than the prevailing westerlies.

Storms are an important climatic impact driver for the UK and there has been considerable debate on whether storminess is increasing. Recent studies explored in CCRA3 conclude that there is no clear evidence for increased storminess. Trends in storm activity depend critically on the time period analysed, and the apparent increase in storminess between 1960 and 1990 is actually part of a longer-term record that reveals multi-decadal variability. More research is needed to address this important question for the UK, since major storms can cause widespread damage, from flooding, winds and waves to coastal storm surges, all of which can affect the electricity system.

The impact of Arwen and other recent storms on the electricity network has highlighted the issue of the resilience of the sector, prompting questions across Government as to whether enough is being spent on protecting Britain's grid against extreme weather and whether emergency response measures are sufficient. Ofgem, the industry regulator, has launched a review into the response to Storm Arwen.

Source: BBC News (2021) *Storm Arwen: Thousands spending third night without power.* Available at: https://www.bbc.co.uk/news/uk-scotland-59451287; Slingo, J. (2021) Latest scientific evidence for observed and projected climate change. *The third UK Climate Change Risk Assessment Technical Report.*

c) Risk management score

Risk management in this area is scored as low with a limited set of relevant indicators monitored.

The management of climate risks within this priority area is scored as **low**. Indicators of adaptation and resilience in the energy system are not available for Scotland and are not being monitored by the Scottish Government. Recent storms have demonstrated the potential for significant impacts on the electricity system and knock-on impacts which can cascade across society, but evidence on future storminess is inconclusive. The impact of Storm Arwen demonstrates that Scotland's energy networks are not well prepared for extreme weather.

- **Five power stations and 34 electricity substations in Scotland are currently at significant risk of surface water flooding.** Research on current and future flood risk included in CCRA3 provided an update on flood risk to electricity assets in Scotland using UKCP18 projections. Under current levels of adaptation, the number of assets at risk is expected to increase under a range of climate change scenarios (Figure 5.1).

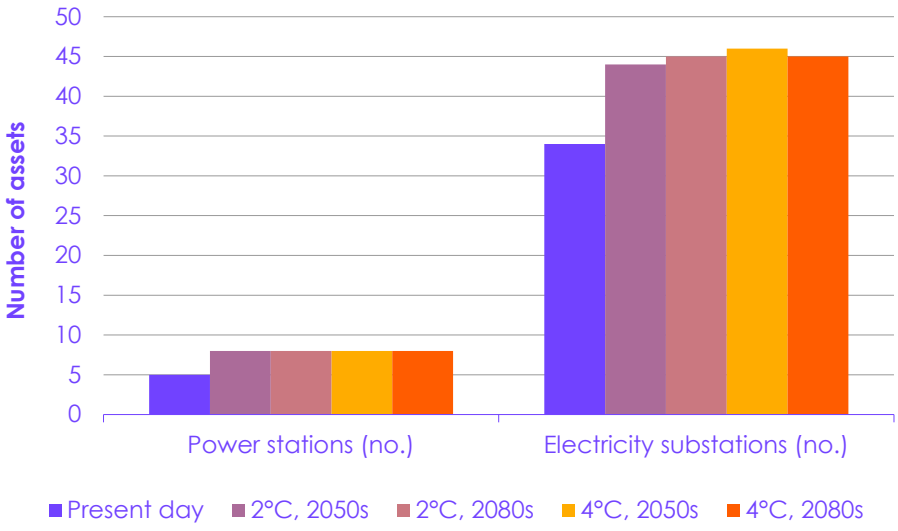
- **Indicators for electricity supply disruption for Scotland are not available.** The number of electricity supply interruptions caused by severe weather events is not publicly available for Scotland. Previously these indicators were updated by ClimateXChange, commissioned by Scottish Government.

- **Storm Arwen left 40,000 people without power for four nights.** The impacts of Storm Arwen indicate that the electricity network in Scotland may not be well prepared for extreme weather events (Box 5.1).

The adaptation reporting power returns indicate that adaptation actions are happening across the sector, but evidence on individual generators is limited.

- **ARP3 reports provide an update on the progress of adaptation actions in the energy sector.** Electricity transmission & distribution companies and gas network operators have presented an update on adaptation actions progressed over the last 5 years – there is evidence of a range of action taking place. Energy UK has presented a sector-level summary for energy generators, though specific information on actions taken by individual generators is lacking.

Figure 5.1 Number of electricity assets in Scotland at significant risk of surface water flooding under different climate change scenarios



Source: Sayers et al (2020). *Third UK Climate Change Risk Assessment (CCRA) Future flood risk.*
Notes: Data extracted for the CCRA3 technical chapters from the results database available at www.ukclimaterisk.org. The climate scenarios presented above assume current levels of adaptation and low population growth in the mid and late century.

2. Public water supply infrastructure

Progress summary – Public water supply infrastructure
Plan score: Low • An adaptation plan is not yet in place for water supply infrastructure in Scotland, though it is under development. • Climate change impacts on public water supply resilience have been considered in various sector strategies and plans. • Leakage targets are set and monitored by the regulator, though these are determined on an economic basis and not based on exposure to climate risk. **Risk management score: Medium** • Though Scotland is projected to have an overall surplus of water, supply-demand deficits are projected for some water resource zones in Scotland by the 2050s, with more extensive deficits projected in the 2080s. • Leakage from the public water supply system continues to reduce and targets are being met, though progress has slowed in recent years.
Relevant risks from CCRA3: • I2 Risks to infrastructure services from river, surface water and groundwater flooding • I3 Risks to infrastructure services from coastal flooding and erosion • I7 Risks to subterranean and surface infrastructure from subsidence • I8 Risks to public water supplies from reduced water availability More information on the related risks can be found in CCRA technical report chapter 4, Scotland National Summary, Water Sector Briefing.

a) Introduction

This priority area considers progress in ensuring water provision is resilient to climate change.

Resilient water supply infrastructure and improved water efficiency are required together to reduce the vulnerability of water supplies to climate change. This adaptation priority covers the resilience of public water supply infrastructure in Scotland. Private supplies and the effectiveness of current water efficiency measures are considered under the 'water demand in the built environment' priority.

Future projected climate changes put some parts of Scotland at risks of water shortages.

The latest projections of future water availability for CCRA3 show that without additional adaptation actions, some water resource zones in Scotland will be in supply-demand deficit by the mid-century, under both 2°C and 4°C warming scenarios (assuming a central estimate of future population growth), and an increasing number will be in deficit by the late century. * Though Scotland is projected to have an overall supply-demand balance surplus, transfers of water between surplus and deficit areas are likely to be prohibitively expensive due to challenging terrain in many cases.

There are additional risks from climate change on water supply beyond the overarching supply-demand balance. The key climate and weather-related risks to

* Supply-demand deficit refers to when the balance between the demand for water and available supplies is insufficient to maintain an acceptable reliability of supply to customers. Acceptable reliability of supply is defined in terms of the ability to satisfy specified levels of service relating to the frequency and severity of shortages.

water supply infrastructure in Scotland are possible increases in leakage and burst frequency due to increased flooding risk, and increased risk of subsidence and soil shrink-swell damage.

Water policy is fully devolved to the Scottish Government.

Water policy is fully devolved to the Scottish Government. Organisations with a role in the resilience of public water supply infrastructure are:

- Scottish Water: operates the public water supply system
- Scottish Government: sets objectives for Scottish Water
- Water Industry Commission for Scotland (WICS): regulates the water sector
- Scottish Environment Protection Agency (SEPA): responsible for environmental protection and improvement.

b) Planning score

Adaptation planning in this priority area is scored as low but could improve in future.

The quality of plans is assessed as **low** but improving.* A dedicated adaptation plan is not yet in place for the water sector in Scotland nor is adaptation adequately integrated into other strategies in this sector.

Scottish Water are currently developing a climate change risk assessment for the 2021-27 period, exploring the potential impacts of 2°C and 4°C global warming scenarios on water supply infrastructure to the end of this century, and designing an adaptation plan to address these. Publication of this plan is expected in 12 to 18 months and would be expected to increase the planning score in the future.

- **Adaptation actions in plans.** Scottish Water's statutory objectives for 2021-2027 (set by the Scottish Government) include identifying the impacts of climate change on its assets and preparing and implementing plans for adaption measures necessary to protect its services[2]. The 25-year Water Resources Management Plan (2015) sets out Scottish Water's strategy to meet these objectives. It includes a vulnerability assessment of water availability based on the UKCP09 climate projections for the UK[3]. While there are no specific adaptation actions set out in Scottish Water's Strategic Plan (2020), it recognises the climate crisis as Scottish Water's biggest challenge, with adapting to climate change part of the three strategic outcomes. SEPA's Water Supply and Wastewater Sector plan includes high-level aims to:
  - Ensure opportunities to reduce leakage are taken when buildings are being refurbished or other infrastructure is being maintained or renewed.
  - Enable Scottish Water to find new ways of efficiently detecting and fixing leaks, targeting areas where the ability to meet demand for drinking water is threatened by climate change and population growth or where opportunities to reduce energy and chemical use are greatest.[4]

* Relevant plans and policies for this priority area are: statutory objectives for 2021-2027 for Scottish Water; Scottish Water's 25-year Water Resources Management Plan (2015); SEPA's Water Supply and Wastewater Sector.

Leakage targets are in place but don't explicitly take account of climate change in determining their level.

- **SMART objectives.** Leakage targets are a key mechanism for reducing the amount of water lost through the supply system. While Scottish Water does have targets for leakage, which are set and monitored by WICS, the level of acceptable leakage is determined on an entirely economic basis, and does not take a long-term approach of identifying the leakage reduction rates that may be needed to help ensure adequate water supplies are maintained despite climate change.* Targets for leakage have not changed in six years, as these were previously aligned to the 2015–21 investment period. The approach to setting targets for leakage is currently under review. There are no targets for reducing interruptions to supply, though Scottish Water has an aspiration in its 25-year water resource planning strategy to have no long-term supply interruptions at customers' taps.

- **Monitoring and evaluation.** A monitoring and evaluation framework is being developed for the forthcoming adaptation plan. Some key metrics are currently being monitored, including leakage and interruptions to supply.

- **Consideration of multiple climate scenarios.** Scottish Water completed climate change risk assessments during the 2010-15 (SR10) and 2015-21(SR15) investment periods; a further risk assessment is planned for 2021-27, which will consider 2°C and 4°C warming scenarios over multi-decadal timespans.

c) Risk management score

Climate risk management in this priority area is scored as medium.

The management of climate risks is assessed as **medium.** Supply-demand deficits are projected for some areas of Scotland, but progress is being made on reducing leakage which will decrease the risk to some extent. Investments in water supply infrastructure are increasing but data on weather-related disruption to supply are not available.

- **Supply-demand deficits are projected for some water resource zones in Scotland by the 2050s, with more extensive deficits projected in the 2080s.** The projections of future water availability for CCRA3 state that Scotland will have an overall supply-demand balance surplus by both the mid and late-century†, but several Scottish water resource zones will be in deficit (Figure 5.2 and Figure 5.3).5 There is an assumption that deficits can be resolved by transferring water between regions, but this may be prohibitively expensive in practice and restricted by topography, particularly in Scotland. This does not include Scotland's extensive private water supplies (see 'Water demand in the built environment' priority).

Leakage levels are reducing but at a slowing rate.

- **Leakage from the public water supply system continues to reduce.** Targets are being met, however progress has slowed in recent years. Leakage from the public water supply system has been reducing since 2010. Leakage in 2020/21 was 463 Ml/d, 34% lower than in 2010/11 and well below the target set by WICS (Figure 5.4). Progress in reducing leakage has slowed in recent years and saw almost no change in the most recent reporting year. Scottish Water attributes this largely to extreme and sustained cold temperatures in early 2021 which led to an increase in burst pipes and resultant water losses.

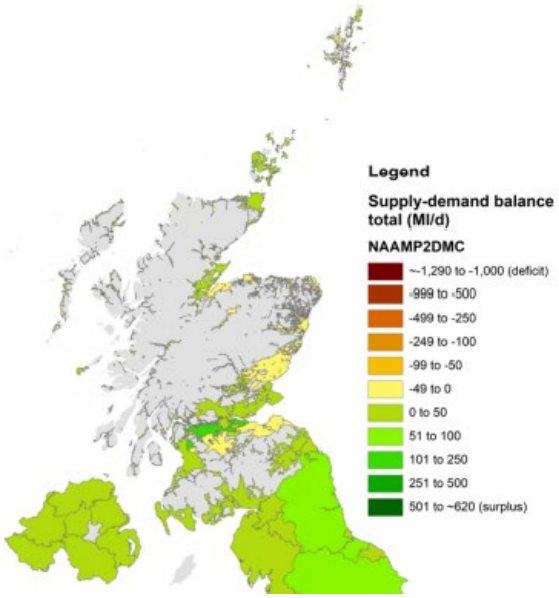
* The Economic Level of Leakage (ELL) is the point where the cost of reducing leakage becomes greater than the savings from reduced water production.

† Under a central population projection with no additional adaptation for a +2°C and +4°C at 2100 scenarios.

Scottish Water is working on approaches to improve forecasting of when weather events may occur.

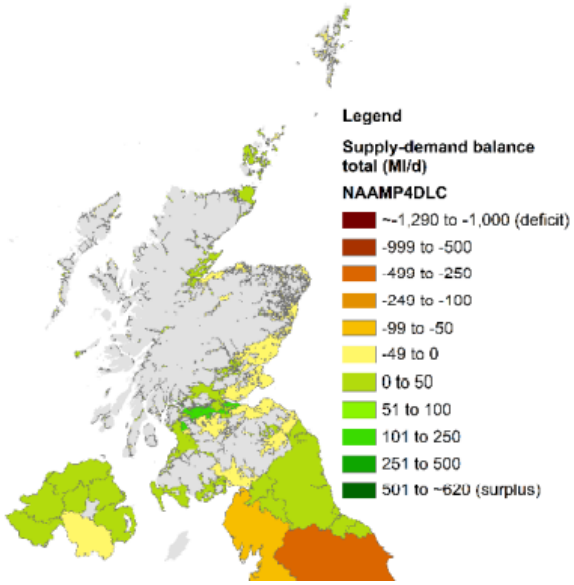
Some parts of Scotland could have water demand deficits when accounting for future climate change.

Figure 5.2 Mid-century supply-demand balance, 2°C world



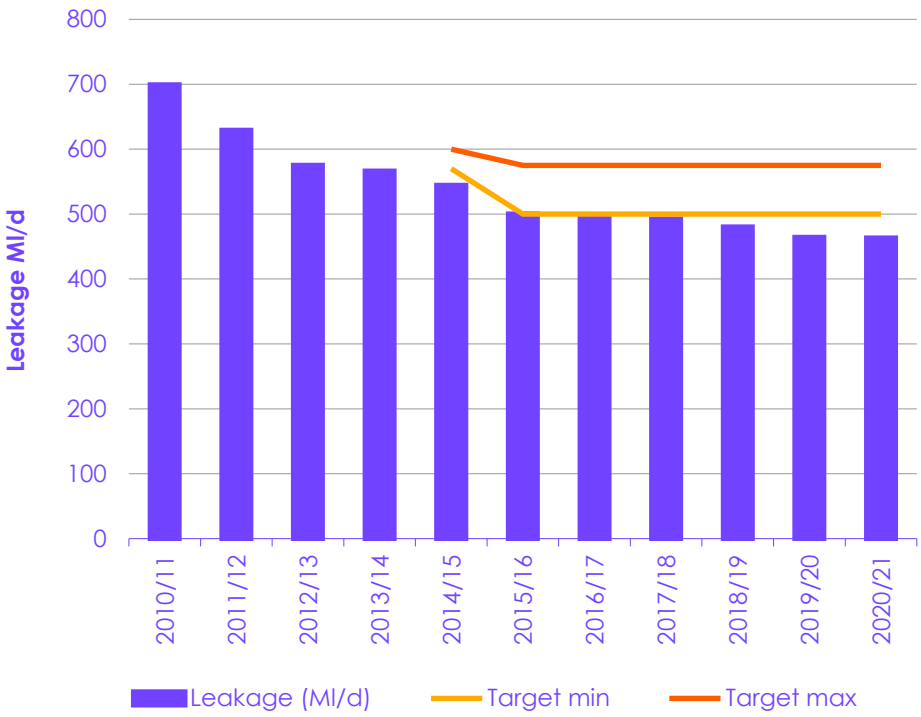
Source: HR Wallingford (2020). *Technical Report, Updated projections of future water availability for the third UK Climate Change Risk Assessment*, RT002 R05-00. Report produced for Committee on Climate Change.
Notes: Shows supply-demand balance in the mid-century, in a 2°C world, central population projection and assuming no additional adaptation action, at the water resource zone scale. Yellow zones are in supply-demand deficit. Grey zones are not connected to the public supply system.

Figure 5.3 Late-century supply-demand balance, 4°C world



Source: HR Wallingford (2020). *Technical Report, Updated projections of future water availability for the third UK Climate Change Risk Assessment*, RT002 R05-00. Report produced for Committee on Climate Change.
Notes: Shows supply-demand balance in the late-century, in a 4°C world, central population projection and assuming no additional adaptation action, by water resource zone. Yellow zones are in supply-demand deficit. Grey zones are not connected to the public supply system.

Figure 5.4 Scottish Water leakage from public supply system (2010/11 - 2020/21)



Source: Data from Scottish Water Annual Report 2020/21 and Scottish Water Annual Return to Water Industry Commission for Scotland 2018/19.
Notes: Purple bars show actual leakage from the public supply system from 2010/11 to 2020/21. Orange bars show the target level of leakage for each year from 2014/15, set by WICS. Target data prior to 2014/15 not available.

- **Investments in water infrastructure are increasing.** Scottish Water is investing around £600 million in Scotland's water infrastructure, although the extent of investment in climate resilience measures is not known.[6] Scottish Water is consulting on priorities for future investment for 2021-27 and beyond.

The frequency of water supply interruptions due to extreme weather specifically isn't known.

- **Interruptions to supply caused by severe weather are not known.** Data from Scottish Water shows that unplanned interruptions to supply in 2020 were well below delivery plan targets, however data on interruptions caused by severe weather is not available.

3. Airports

Progress summary – Airports
Plan score: Low • Adaptation is referenced at a high level in some transport plans • Glasgow and Edinburgh airports have reported their adaptation plans in ARP3 but no plans were found for other airport operators in Scotland. **Risk management score: Low** • There are no available indicators to assess the risk • Glasgow and Edinburgh airports have presented an updated assessment of risks consistent with 2°C and 4°C warming scenarios and an update on adaptation actions in their submissions for ARP3.
Relevant risks from CCRA3: • I1 Risks to infrastructure networks (water, energy, transport, ICT) from cascading failures • I2 Risks to infrastructure services from river, surface water and groundwater flooding • I3 Risks to infrastructure services from coastal flooding and erosion • I12 Risks to transport from high and low temperatures, high winds, lightning More information on the related risks can be found in CCRA technical report chapter 4, Scotland National Summary, Transport Sector Briefing.

a) Introduction

Airports can be affected by storms, flooding and erosion for coastal sites. Air services are currently vital for connecting some of Scotland's more remote communities.

This adaptation priority covers the resilience of airports. Air services are particularly important for Scotland's islands, providing important connectivity to local communities. Lifeline air services are operated from Glasgow to Barra, Tiree and Cambelltown, which would otherwise not be viable commercial routes for airlines.* Airports are affected by extreme weather, heat, sea level rise, flooding and coastal erosion. UK and Scottish sea levels are continuing to rise leading potentially to more severe and frequent coastal erosion and coastal flooding risks. The decline of natural buffering systems, such as salt marshes, shingle and sand dunes also increase the vulnerability of Scotland's significant infrastructure assets in coastal areas.

Climate impacts which cascade across different types of infrastructure are covered in the priority area: Infrastructure Interdependencies.

Aviation policy remains reserved. All airports, regardless of ownership, are regulated by the Civil Aviation Authority which is a public corporation of the Department for Transport. For the 11 Highlands & Islands Airports Limited (HIAL) airports and Glasgow Prestwick Airport, the Scottish Government acts as shareholder rather than regulator.

* Lifeline services are understood to mean routes which are subsidised by the Scottish Government, as previously required under EU law to 'provide the public with adequate transport services'.

b) Planning score

Adaptation planning in this priority area is scored as low.

The consideration of a changing climate in planning for this area is scored as **low**.* Adaptation is referenced at a high level in some transport plans. Edinburgh and Glasgow airport have adaptation plans but no plans were found for other airport operators.

- **Adaptation actions in plans.** In February 2021, the Strategic Transport Projects Review Phase 1 report was published, which will inform Scottish Government's transport investment programme from 2022-2042. There was limited reference to adaptation, but one objective covered 'a reliable and resilient strategic transport system that is safe and secure for users', although without specific reference to climate risks. The Transport Strategy 2 (2020) mentions adapting to a changing climate. It includes climate action as one of its four priorities with adapting to the effect of climate change as part of this. However, the Transport Scotland Corporate Plan which provides detail on the delivery of the strategy does not include any adaptation actions for the year 2020-2021 relating to airports. The National Islands Plan (2019) also touches on island transport links, recognising that transport links are essential for island communities, both within and between islands. Transport Scotland is developing an adaptation strategy for the whole organisation which will cover aviation, roads, maritime and rail. It is due to be published in early 2022. Edinburgh and Glasgow airports each have a detailed programme of adaptation measures, setting out how these airports plan to manage their climate risks, presented in their ARP3 reports.

'SMART' adaptation objectives are only in place for the major airports of Edinburgh and Glasgow.

- **SMART objectives.** Adaptation plans for Edinburgh and Glasgow airports' ARP3 reports set out their objectives for adaptation. None of the other plans include fully SMART objectives to deliver their aims on climate change adaptation.

- **Monitoring and Evaluation.** Transport Scotland published a monitoring and evaluation framework for the National Transport Strategy 2 in August 2021, which includes commitments to report annually against headline indicators. The first report will cover the period to end of March 2022. There will also be a three-yearly evaluation report which draws together additional data to provide a comprehensive overview of performance against the outcomes and vision. The indicators in the M&E framework do not directly relate to adaptation or increasing the resilience of transport networks, although there are indicators on casualties, safety and air quality. M&E for Edinburgh and Glasgow airports' adaptation plans are set out in their ARP3 reports.

- **Consideration of multiple climate scenarios.** The National Transport Strategy 2 does not reference different climate scenarios. Edinburgh and Glasgow airports have assessed their risks under scenarios consistent with 2°C and 4°C warming in the 2050s and 2080s.

* Relevant plans and policies relating to weather and climate resilience airports are: the National Transport Strategy 2 (2020); Transport Scotland Corporate Plan 2020-2021.

c) Risk management score

Climate risk management in this priority area is currently scored as low.

The management of climate risks within this priority area is scored as **low**. Glasgow and Edinburgh airports have presented updated climate risk assessments and progress in adaptation actions in their submissions for ARP3, however other Scottish airports have not been invited to report.

There is a lack of data to assess how airports are currently managing climate risk.

- **Indicators to assess the risk are not available.** There are no data to assess whether steps are being taken by airports to manage the risks of climate change.

- **Glasgow and Edinburgh Airports have submitted an updated assessment of climate risks and progress in adaptation action for ARP3.** There is evidence that a range of adaptation actions have been progressed.

4. Ports and ferries

Progress summary – Ports and ferries
Plan score: Low • Adaptation is referenced at a high level in some plans, but no specific plans were found for port operators or covering ferry services. • The plan score could increase in future if the Transport Scotland adaptation strategy and the Islands Connectivity Plan include specific adaptation actions for ferry services. **Risk management score: Low** • There are no available indicators to assess the risk.
Relevant risks from CCRA3: • I1 Risks to infrastructure networks (water, energy, transport, ICT) from cascading failures • I2 Risks to infrastructure services from river, surface water and groundwater flooding • I3 Risks to infrastructure services from coastal flooding and erosion • I12 Risks to transport from high and low temperatures, high winds, lightning More information on the related risks can be found in CCRA technical report chapter 4, Scotland National Summary, Transport Sector Briefing.

a) Introduction

Ports and ferries are critical to keeping remoter parts of Scotland connected and can be affected by many climate and weather hazards – particularly sea level rise and coastal erosion.

This adaptation priority covers the resilience of ports and ferry services. Ferry services are particularly important for Scotland's islands, providing important connectivity to local communities. More than two thirds of Scotland's ferry passengers are on 'lifeline services' serving the Clyde, West Coast and Northern Isles.[7*] Ports and ferry services are affected by extreme weather, heat, sea level rise, flooding and coastal erosion. UK and Scottish sea levels are continuing to rise leading potentially to more severe and frequent coastal erosion and coastal flooding risks. The decline of natural buffering systems, such as salt marshes, shingle and sand dunes also increase the vulnerability of Scotland's significant infrastructure assets in coastal areas.

Climate impacts which cascade across different types of infrastructure are covered in the priority area: Infrastructure Interdependencies.

Maritime policy remains reserved, although the Scottish Government has devolved responsibility for some ports-related activities, such as the consideration of harbour orders necessary to accommodate infrastructure works. Ferry services are a devolved area.

* Lifeline services are understood to mean routes which are subsidised by the Scottish Government, as previously required under EU law to 'provide the public with adequate transport services'.

b) Planning score

Adaptation planning within this priority area is overall scored as low.

The consideration of a changing climate in planning for this area is scored as **low**.* Adaptation is referenced in some high-level plans, but no specific plans were found for port operators or covering ferry services.

A new adaptation strategy that is in development could see the planning score increase in future.

Transport Scotland is developing an adaptation strategy for the whole organisation which will cover aviation, roads, maritime and rail. It is due to be published in early 2022. An Islands Connectivity Plan (ICP) will be the successor to the Scottish Ferries Plan and is due to be developed in 2022. It is not currently expected to include specific reference to climate change adaptation. The plan score could increase in future if the Transport Scotland adaptation strategy and the Islands Connectivity Plan include specific adaptation actions for ferry services.

- **Adaptation actions in plans.** In February 2021, the Strategic Transport Projects Review Phase 1 report was published, which will inform Scottish Government's transport investment programme from 2022-2042. There was limited reference to adaptation but one objective covered 'a reliable and resilient strategic transport system that is safe and secure for users', although without specific reference to climate risks.

  The Transport Strategy 2 (2020) mentions adapting to a changing climate. It includes climate action as one of its four priorities with adapting to the effect of climate change as part of this, however, the Transport Scotland Corporate Plan which provides detail on the delivery of the strategy does not include any adaptation actions for the year 2020-2021 relating to ports or ferries. The Transport Scotland Ferries Plan does not mention climate risks or adaptation.

  The National Marine Plan (2015) considers adaptation across objectives and sectors, including a specific section on adaptation under each sector.

  The National Islands Plan (2019) also touches on ferries and island transport links, recognising that transport links are essential for island communities, both within and between islands. The plan has an objective to produce a long-term plan for new ferries and development at ports to improve resilience, but this has not been developed yet.

  CalMac is the major operator of passenger and vehicle ferries between mainland Scotland and 22 of Scotland's islands. CalMac's Environmental Strategy 2021-2023 identifies 'a reliable ferry and port operation that is resilient to climate change' as one of four core priorities. It references a Climate Change Risk Assessment, but this was not publicly available for review.

- **SMART objectives.** None of the plans include fully SMART objectives to deliver their aims on climate adaptation. The National Marine Plan includes a policy for port and harbour operators to take into account future climate change projections but it is unclear how this would be achieved or measured.

- **Monitoring and Evaluation.** Transport Scotland published a monitoring and evaluation framework for the National Transport Strategy 2 in August 2021, which includes commitments to report annually against headline indicators.

* Relevant plans and policies relating to weather and climate resilience of ports and ferries are: the National Transport Strategy 2 (2020); Transport Scotland Corporate Plan 2020-2021; the National Marine Plan (2015); the Transport Scotland Ferries Plan (2012); and the CalMac Environmental Strategy 2021-2023. A new ferries plan is due to be developed in 2022. No specific adaptation plans were found for ports.

The first report will cover the period to end of March 2022.
There will also be a three-yearly evaluation report which draws together additional data to provide a comprehensive overview of performance against the outcomes and vision. The indicators in the M&E framework do not directly relate to adaptation or increasing the resilience of transport networks, although there are indicators on casualties, safety and air quality. The National Marine Plan is reviewed every 3 years.

Some usage of climate projections is now out of date and likely to miss some relevant risks.

- **Consideration of multiple climate scenarios.** The National Transport Strategy 2 does not reference different climate scenarios. The National Marine Plan's assessment of climate risks is based on the UK's first climate change risk assessment published in 2012, which uses UKCP09 climate change projections. The Marine Plan (2015) is likely to be missing consideration of some key climate risks as a result. The Marine Plan Review (2021) found a 'clear need' to begin work to replace the existing Marine Plan, since significant external developments have arisen since the original plan was adopted, including impacts from climate change.

c) Risk management score

Climate risks management is scored as low within this priority area.

The management of climate risks within this priority area is scored as **low**. Data are not available to assess the risk and Storm Arwen recently caused disruption to ferry services.

- **Indicators to assess the risk are not available.** There are no data to assess whether steps are being taken by ports and ferry operators to manage the risks of climate change.

- **Storm Arwen in 2021 caused disruption to ferry services in Scotland, with some services cancelled due to adverse weather.** CalMac cancelled all ferry sailings between Arran and Ardrossan on the 26th of November 2021. The alternative route between Arran and Claonaig in Argyll was also cancelled[8], meaning the Isle of Arran had no ferry services running to the mainland for at least one day. This example highlights the potentially greater impacts from climate change on people living in remote or rural areas as disruption to infrastructure services can leave communities isolated (see 'The Just Transition and Climate Change Adaptation' briefing published alongside this report for more detail).

5. Rail network

Progress summary – Rail network
Plan score: High • Scottish Ministers set out expectations for network resilience using the High-Level Output Specification (HLOS), including relating to the impacts of climate change. • Network Rail has a Route Weather Resilience and Climate Change Adaptation Plan for Scotland, based on the UKCP09 high emissions scenario. **Risk management score: Medium** • Weather-related delay minutes have been higher overall in the last three years, although there is no clear long-term trend. • Network Rail has reported under ARP3, presenting an updated climate risk assessment and programme of adaptation measures for the UK rail network.
Relevant risks from CCRA3: • I1 Risks to infrastructure networks (water, energy, transport, ICT) from cascading failures • I2 Risks to infrastructure services from river, surface water and groundwater flooding • I3 Risks to infrastructure services from coastal flooding and erosion • I4 Risks to bridges and pipelines from flooding and erosion • I5 Risks to transport networks from slope and embankment failure • I7 Risks to subterranean and surface infrastructure from subsidence • I12 Risks to transport from high and low temperatures, high winds, lightning More information on the related risks can be found in CCRA technical report chapter 4, Scotland National Summary, Transport Sector Briefing.

a) Introduction

Rail networks can be affected by changes in rainfall patterns which can lead to risks of landslips.

This adaptation priority covers the resilience of rail networks. Rail networks can be affected by changes in rainfall patterns and extreme weather, leading to slope and embankment failures, landslides, flooding and erosion. In 2020, a passenger train hit a landslip and derailed in Stonehaven, following a severe rainfall event (Box 5.2). In future, modelling shows that changes in soil moisture will lead to increased risk of failures and is likely to be the most significant geological hazard to UK infrastructure.[9] Storms Ciara and Denis in 2020 disrupted rail services. Some modelling was included in CCRA2 indicating that increased winter precipitation and river flows will increase damage to bridge abutments or piers, potentially putting 1 in every 20 bridges at high risk by 2080.[10]

Climate impacts which cascade across different types of infrastructure are covered in the priority area: Infrastructure Interdependencies.

Scottish Government manages the ScotRail and Caledonian Sleeper franchises and is ultimately responsible for the operation of rail services. Network Rail Scotland is responsible for managing rail infrastructure assets across Scotland.

b) Planning score

There is high quality adaptation planning in place across this priority area.

The consideration of a changing climate in planning for this area is scored as **high**.* Network Rail has a good resilience and adaptation plan for Scotland. Scottish Ministers set out expectations for network resilience using the High-Level Output Specification (HLOS), including relating to the impacts of climate change.

In January 2022, a draft report of the second Strategic Transport Projects Review (STPR2) was published for consultation, which will inform Scottish Government's transport investment programme from 2022-2042. Transport Scotland is developing an adaptation strategy for the whole organisation covering aviation, roads, maritime and rail. This is expected to be published in early 2022.

- **Adaptation actions in plans.** The Transport Strategy 2 (2020) and Fitting Landscapes policy (2014) both mention adapting to a changing climate. The Transport Strategy includes climate action as one of its four priorities with adapting to the effect of climate change as part of this. The Transport Scotland Corporate Plan provides detail on the delivery of the strategy and includes an objective to support 'resilience and efficient' rail operations. The HLOS† references reducing disruption to the rail network from climate change. The Network Rail Route Weather Resilience and Climate Change Adaptation Plan for Scotland sets out programmes and initiatives designed to increase the resilience of the railway in Scotland to the effects of weather and climate change. The latest plan is from 2014 and is based on UKCP09 projections.

- **SMART objectives.** The Network Rail Weather Resilience and Climate Change Adaptation (WRCCA) plan sets out SMART adaptation objectives for each of the projected climate impacts on the Scotland route. All actions have timescales. None of the other plans include fully SMART objectives to deliver their aims on climate adaptation.

There is a monitoring and evaluation framework in place that reports on indicators related to adaptation considerations.

- **Monitoring and Evaluation.** Transport Scotland published a monitoring and evaluation framework for the National Transport Strategy 2 in August 2021, which includes commitments to report annually against headline indicators. The first report will cover the period to end of March 2022. There will also be a three-yearly evaluation report which draws together additional data to provide a comprehensive overview of performance against the outcomes and vision. Although the indicators in the M&E framework do not directly report on adaptation or increasing the resilience of transport networks, there are related indicators with respect to casualties, safety and air quality. Actions within the Network Rail WRCCA plan are monitored through Network Rail governance processes and progress is reported every six months.

The HLOS requires Network Rail to develop and apply suitable KPIs for monitoring the impact of climate change on network disruption and the benefits of adaptation actions. This is a good example of Scottish Ministers exercising influence over a reserved area of policy to ensure a resilient rail service for Scottish passengers.

* Relevant plans and policies relating to resilience of the rail network are: the Transport Strategy 2 (2020) and its Monitoring and Evaluation Framework (2021); Transport Scotland Corporate Plan 2020-2021; the Fitting Landscapes policy (2014) on design and management of transport corridors; and Network Rail's Route Weather Resilience and Climate Change Adaptation Plan (WRCCA).

† Scottish Ministers lay out their requirements for the rail industry in the High-Level Output Specification (HLOS), most recently for the period 2019-2024.

- **Consideration of multiple climate scenarios.** The Network Rail WRCCA plan for Scotland is based on the high emissions scenario from UKCP09**.** None of the other plans reference different climate scenarios and the Fitting Landscapes policy was published too long ago to incorporate the most recent evidence from UKCP18 climate projections and recent climate change risk assessments.

c) Risk management score

The management of climate risks in this priority area is scored as medium.

The management of climate risks within this priority area is scored as **medium**. Network Rail has reported under ARP3, presenting an updated climate risk assessment and programme of adaptation measures. There has been increased disruption to rail services from some hazards in recent years but no long-term trend.

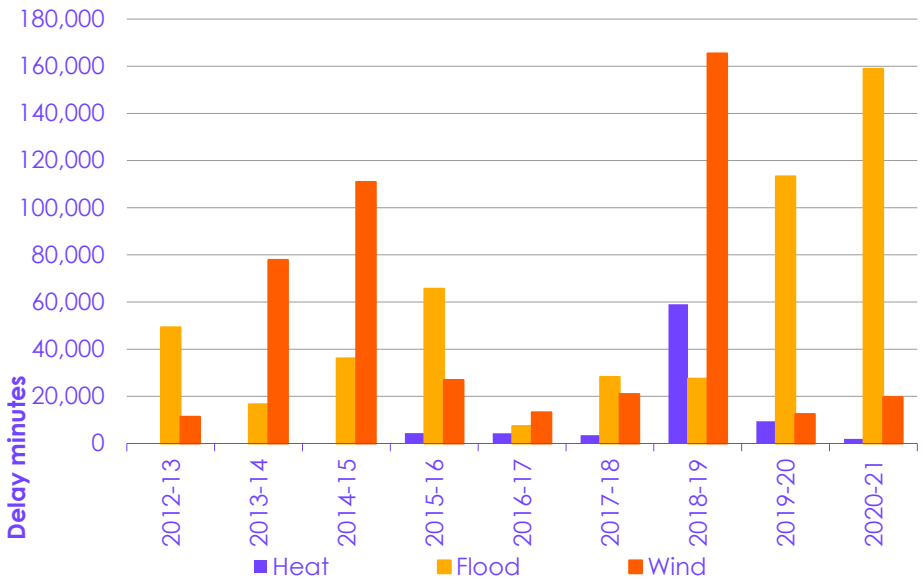
- **Network Rail has reported under ARP3 and is making good progress in implementing adaptation actions across the UK rail network.** The report presents an updated climate risk assessment based on UKCP18 projections and a comprehensive programme of adaptation measures. Most actions from the ARP2 report in 2016 have been completed or progressed.

- **Flood-related disruption to rail services has increased in recent years.** Figure 5.5 shows the total minutes delay for heat, flood and wind-related weather incidents. 2020/2021 is considered an outlier due to reduced services for parts of the year. The data also show an increase in the number of heat-related weather incidents in Scotland per year, with 187 incidents in 2018-2019.

Recent years have seen relatively high levels of weather related disruption but the year-to-year weather variability complicates the picture for determining how well the risks are being managed.

- **Overall weather-related disruption to rail services has been higher in recent years.** Network Rail data shows higher weather-related delay minutes in the last three years, although there is no clear trend overall. The short time period of this data and year-to-year variability in the frequency and magnitude of weather extremes means that it is not possible to straightforwardly attribute this as evidence of the quality of risk management. Particular weather-related incidents have however caused severe impacts, including the Stonehaven derailment in August 2020 (Box 5.2).

Figure 5.5 The total number of minutes delay per type of weather-related incidents in Scotland (2012/13 - 2020/21)



Source: Network Rail (unpublished).
Notes: Data do not include long-term closures as a result of severe weather. While this is recorded, Network Rail report that the data collection is not consistent enough to give reliable data on longer term closures. Minutes delay reflects delays to trains, does not cover passenger numbers

Box 5.2
Stonehaven derailment

Following a fatal train derailment in Scotland in August 2020, the Secretary of State for Transport requested a wider assessment of the impact of extreme weather on the resilience and safe performance of the rail network. Network Rail published the findings of two independent task forces - a Weather Advisory Task Force (WATF) and an Earthworks Management Task Force – in March 2021.* Neither taskforce was tasked with assessing how Network Rail is responding to the challenge of future climate change, however implementation of the recommendations will address some of the challenges facing the railway. The major recommendations for Network Rail from the Weather Advisory Task Force include:

- Formal trial of the latest forecasting capabilities with the Met Office;
- Improvements in assessing the probability of earthwork failures, using forensic analysis of selected events to provide a complete picture of the context surrounding earthwork failures;
- Urgent transformation of the delivery of weather services, by considering the development of a new hazard and impact-based digital platform;
- A partnership-driven, integrated transport hub to provide 24/7 access to all operational services and expert advice, including flooding, and thus deliver an authoritative set of services across Network Rail routes and regions;
- Building its professional competencies in meteorology, hydrology and climate change so that staff can act as intelligent users of science and services across all its functions.

Source: Network Rail (2021) *Weather Advisory Task Force, Final Report.*

* The two taskforces were overseen by Dame Julia Slingo and Lord Robert Mair, both of whom have authored and advised on the CCRA3 Technical Report.

6. Road network

Progress summary – Road Network
Plan score: Medium • Adaptation is referenced in several relevant plans and policies for roads but with limited detail. The upcoming adaptation strategy and adaptation and resilience plan for roads from Transport Scotland could increase this score to high in future **Risk management score: Low** • Data for weather-related road disruptions were not available.
Relevant risks from CCRA3: • I1 Risks to infrastructure networks (water, energy, transport, ICT) from cascading failures • I2 Risks to infrastructure services from river, surface water and groundwater flooding • I3 Risks to infrastructure services from coastal flooding and erosion • I4 Risks to bridges and pipelines from flooding and erosion • I5 Risks to transport networks from slope and embankment failure • I7 Risks to subterranean and surface infrastructure from subsidence • I12 Risks to transport from high and low temperatures, high winds, lightning More information on the related risks can be found in CCRA technical report chapter 4, Scotland National Summary, Transport Sector Briefing.

a) Introduction

The road network can be affected by many weather hazards including flooding and slope and embankment failure.

This adaptation priority covers the resilience of the trunk road network (major roads connecting larger towns and cities). The road network can be affected by changes in rainfall patterns and extreme weather, leading to slope and embankment failures, landslides, flooding and erosion. In future, modelling shows that changes in soil moisture will lead to increased risk of failures and is likely to be the most significant geological hazard to UK infrastructure.[11] Storms Ciara and Denis in 2020 also disrupted road services. Some modelling was included in CCRA2 indicating that increased winter precipitation and river flows will increase damage to bridge abutments or piers, potentially putting 1 in every 20 bridges at high risk by 2080.[12]

Climate impacts which cascade across different types of infrastructure are covered in the priority area: Infrastructure Interdependencies.

All policy related to the trunk road network, including structures and bridges, is devolved to the Scottish Government.

b) Planning score

Adaptation planning in this priority area is scored as medium overall.

The consideration of a changing climate in planning for this area is scored as **medium**.* Adaptation is referenced in several relevant plans and policies for roads but with limited detail. The upcoming adaptation strategy and adaptation and resilience plan for roads from Transport Scotland could increase this score to high in future.

In January 2022, a draft report of the second Strategic Transport Projects Review (STPR2) was published for consultation, which will inform Scottish Government's transport investment programme from 2022-2042. It recommends additional investment to provide a safe and reliable motorway and trunk road network, including recommendations for Transport Scotland to continue to assess the network and implement a programme of renewals and measures that will address safety (recommendation 30), climate change adaptation (recommendation 31) and resilience (recommendation 32). STPR2 has considered these requirements and identified a series of routes and locations to prioritise.

Transport Scotland is developing an adaptation strategy for the whole organisation covering aviation, roads, maritime and rail. A separate climate change adaptation and resilience plan is also being developed for roads. These are expected to be published in early 2022.

- **Adaptation actions in plans.** The Transport Strategy 2(2020), Fitting Landscapes (2014) and High Wind Strategy (2009) all mention adapting to a changing climate. The Wind Management Strategy is also currently being reviewed and will be informed by a bespoke wind modelling report completed by the Met Office. The Transport Strategy includes climate action as one of its four priorities with adapting to the effect of climate change as part of this. The Transport Scotland Corporate Plan provides detail on the delivery of the strategy and also details action to deliver trunk road improvements to strengthen overall network resilience for the year 2020-2021.

'SMART' adaptation relevant objectives are currently not present in any relevant plans.

- **SMART objectives.** None of the plans include fully SMART objectives to deliver their aims on climate adaptation but in the case of roads, the climate change adaptation and resilience plan could fill this gap.

- **Monitoring and Evaluation.** Transport Scotland published a monitoring and evaluation framework for the National Transport Strategy 2 in August 2021, which includes commitments to report annually against headline indicators. The first report will cover the period to end of March 2022. There will also be a three-yearly evaluation report which draws together additional data to provide a comprehensive overview of performance against the outcomes and vision. The indicators in the M&E framework do not directly relate to adaptation or increasing the resilience of transport networks, although there are indicators on casualties, safety and air quality.

* Relevant plans and policies relating to resilience of the road network are: the Transport Strategy 2 (2020) and its Monitoring and Evaluation Framework (2021); Transport Scotland Corporate Plan 2020-2021; Fitting Landscapes policy (2014) on design and management of transport corridors; and the High Wind Strategy and National Wind Management Guidelines (2009) for roads.

- **Consideration of multiple climate scenarios.** None of the plans reference different climate scenarios and both the Fitting Landscapes policy and High Wind Strategy were published too long ago to incorporate the most recent evidence from UKCP18 climate projections and recent climate change risk assessments. However, the review of the High Wind Strategy with input from Met Office modelling is an opportunity to include climate scenarios.

In February 2021, the Infrastructure Investment Plan for Scotland 2021-2022 to 2025-2026 was published, which included a new Roads Adaptation Fund of £60m for the trunk roads network. This fund is expected to be used on trunk road minor improvement schemes to address the impacts of climate change, improve network efficiency, safety and resilience over the period from 2022-2026.

c) Risk management score

There is no relevant data available to assess the extent to which weather-related disruption to roads is changing over time.

The management of climate risks within this priority area is scored as **low**. Data for weather-related road disruptions were not available.

- **Data for weather-related disruption to roads were not available.** No published data for weather-related disruption to roads were found.

7. Resilience of telecoms, digital and ICT infrastructure

Progress summary – Resilience of telecoms, digital and ICT infrastructure
Plan score: Low • The current digital strategy does not address climate risks to telecoms, digital and ICT infrastructure **Risk management score: Low** • Information on the location of digital and ICT infrastructure is not publicly available, meaning the scale of the risk is unknown • There are no data on actions being taken to manage the risks
Relevant risks from CCRA3: • I1 Risks to infrastructure networks (water, energy, transport, ICT) from cascading failures • I2 Risks to infrastructure services from river, surface water and groundwater flooding • I3 Risks to infrastructure services from coastal flooding and erosion • I4 Risks to bridges and pipelines from flooding and erosion • I7 Risks to subterranean and surface infrastructure from subsidence • I13 Risks to digital from high and low temperatures, high winds, lightning More information on the related risks can be found in CCRA technical report chapter 4, Scotland National Summary, Energy Sector Briefing.

a) Introduction

Telecoms, digital and ICT infrastructure can be affected by multiple types of extreme weather.

This adaptation priority covers the resilience of telecoms, digital and ICT infrastructure. This type of infrastructure can be affected by flooding, coastal erosion, high temperatures, extreme weather events and high winds. There is an increase in exposure to weather-related disruptions from gradual decommissioning of old analogue systems and increasing reliance on digital systems for mobile and landline communications. There are also risks to buried infrastructure, such as cables becoming damaged from flooding and subsidence. In particular, the edges of networks are at risk of failure as they have the lower levels of redundancy (alternative connections in place to maintain levels of service despite some failures) and are often in remote areas, sometimes with limited access or rough terrain meaning they take longer to reach for repairs. In Scotland, 4% of premises are without access to 10Mbit per second download speeds and 13% are without mobile network service.[13] If taken as an indicator of properties at the edges of networks, this demonstrates the higher risk in Scotland, particularly in remote or rural communities.

Digital and ICT is of ever growing importance to society and needs to be fully resilient to future weather conditions.

Digital and ICT infrastructure is critical to the operation of wider infrastructure networks and to emergency planning and action. Increased prevalence of ICT in 'smart' infrastructure is rapidly increasing the exposure of ICT assets to climate risks. Climate impacts which cascade across different types of infrastructure are covered in the priority area: Infrastructure Interdependencies.

Digital infrastructure is a reserved policy area, but Scottish Government funds digital initiatives, such as supporting digital transformation or offering digital support for businesses.

b) Planning score

The consideration of a changing climate in planning for this area is scored as **low**.* The new digital strategy does not reference climate risks to digital infrastructure or have specific adaptation relevant actions in place.

There are not yet specific actions in place to help build digital, telecoms and ICT resilience to future climate risks.

- **Adaptation actions in plans.** The digital strategy does not mention climate change, except in the context of using data to support climate change targets, such as monitoring peatland restoration. It does include an aim to ensure new digital infrastructure is 'future-proofed', but in reference to data needs, rather than climate risks. The Infrastructure Investment Plan in its introduction recognises the increasing reliance on digital technology and also that ICT infrastructure 'may face disruptive flooding, landslides, drought and heatwaves'. Neither of the plans include specific adaptation actions for digital infrastructure.

While telecoms, digital and ICT infrastructure policy are reserved matters, the Scottish Government has published a digital strategy. There is scope for this and future digital policy documents to include consideration of the multiple climate risks affecting the telecoms, digital and ICT infrastructure.

SCCAP2 does include two programmes to increase access to superfast broadband and mobile phone coverage in Scotland (Reaching 100 programme and Scottish 4G Infill programme); clear articulation of how these installations will be resilient to expected future weather conditions is required. These are expected to be completed in 2023 and they are a positive step to increase the digital networks in Scotland.

c) Risk management score

There is a lack of relevant datasets to fully assess risk management in this priority area.

The management of climate risks within this priority area is scored as **low**. There is a lack of evidence to assess the risks and the Scottish Government has announced a vision to increase the number of data centres in Scotland.

- **There remains a lack of evidence to assess how risks to telecoms, digital and ICT are changing.** There is no new data on performance of digital infrastructure since the last assessment.

- **Data on the location of digital and ICT infrastructure is not publicly available, meaning the scale of the risk is unknown.** TechUK estimate that there are around 500 data centres in the UK, with only a small proportion of these in Scotland.[14] The exact location of data centres is not publicly available. The Scottish Government set out a vision in 2021 to support a portfolio of different sized Scottish datacentres with actions to establish Scotland as an attractive location for green data centres, which would increase the number of data centres exposed to climate risks in Scotland.[15]

* Relevant plans for this policy area are: A Changing Nation: How Scotland will Thrive in a Digital World (2021), Scotland's digital strategy; and the draft Infrastructure Investment Plan (2020).

8. Design and location of new infrastructure

Progress summary – Design and location of new infrastructure
Plan score: Medium • Current and upcoming Scottish Government policy documents (National Planning Framework 3, National Planning Framework 4 (upcoming) and the Infrastructure Investment Plan) do reference consideration of climate risks in the planning of new infrastructure but they do not include specific adaptation objectives. **Risk management score: Low** • There is no available evidence to assess the risk
Relevant risks from CCRA3: • I1 Risks to infrastructure networks (water, energy, transport, ICT) from cascading failures • I2 Risks to infrastructure services from river, surface water and groundwater flooding • I3 Risks to infrastructure services from coastal flooding and erosion • I4 Risks to bridges and pipelines from flooding and erosion • I5 Risks to transport networks from slope and embankment failure • I6 Risks to hydroelectric generation from low or high river flows • I7 Risks to subterranean and surface infrastructure from subsidence • I8 Risks to public water supplies from reduced water availability • I9 Risks to energy generation from reduced water availability • I10 Risks to energy from high and low temperatures, high winds, lightning • I11 Risks to offshore infrastructure from storms and high waves • I12 Risks to transport from high and low temperatures, high winds, lightning • I13 Risks to digital from high and low temperatures, high winds, lightning More information on the related risks can be found in CCRA technical report chapter 4, Scotland National Summary.

a) Introduction

The design and location of new infrastructure will determine the level of lock-in of infrastructure related climate impacts in future.

This adaptation priority covers the extent to which climate change is being considered in the design and location of major new infrastructure. Climate change needs to be considered in decisions about the design and location of new infrastructure, particularly in relation to possible changes in flood risk, heat, extreme weather, drought, and coastal erosion over the infrastructure lifetime. For new infrastructure with long expected lifetimes, there is significant risk of lock-in to poorly adapted systems that are not resilient to future weather and climate. In future, modelling shows that changes in soil moisture will lead to increased risk of failures and is likely to be the most significant geological hazard to UK infrastructure. Climate impacts which cascade across different types of infrastructure are covered in the priority area: Infrastructure Interdependencies.

b) Planning score

High-level commitments to climate resilience and adaptation are included within plans, but specific actions are generally lacking.

The consideration of a changing climate in planning for this area is scored as **medium**.* Adaptation is referenced in relevant plans, but not in detail.

- **Adaptation actions in plans.** The previous National Planning Framework (NPF3) required the consideration of climate change in the design and location of new infrastructure. The draft NPF4 includes references to resilience and adaptation across the types of places it focuses on, in particular 'Sustainable Places'. This includes a statement that 'new or alterations to, buildings, infrastructure and spaces should be designed to be adaptable to the future impacts of climate change', although it does not explicitly consider the location of new infrastructure. The Infrastructure Investment Plan for 2021-2022 to 2025 - 2026 includes a section on boosting resilience and adaptation through investment in flood risk management and coastal change adaptation. This comprises an additional £150m for flood risk management; almost £12m to be spent on coastal change adaptation; and £60m for adaptation and resilience measures on the trunk road network. It is unclear to what extent these investments will deliver new infrastructure or support maintenance of existing infrastructure.

- **SMART objectives.** NPF4 is a high-level framework, so focuses on outcomes rather than specific objectives. The draft Infrastructure Investment Plan includes a recommendation from the Infrastructure Commission for Scotland, accepted by Scottish Government, to develop a clear implementation plan for critical natural and built infrastructure climate resilience and adaptation by 2023.

- **Monitoring and Evaluation.** Once finalised and approved, NPF4 will be accompanied by a monitoring programme. The draft Infrastructure Investment Plan however, does not yet include any information on what this monitoring and evaluation will look like, nor on its relevance to adaptation.

- **Consideration of multiple climate scenarios.** Neither of the plans reference different scenarios for future changes in weather and climate hazards related to infrastructure design and location in Scotland.

c) Risk management score

No evidence is currently collected on whether new infrastructure is designed and located in areas at risk.

The management of climate risks within this priority area is scored as **low**. There is no evidence collected currently on the management of this risk.

- **There is no available evidence for the management of this risk.** No evidence is currently collected on whether new infrastructure is designed and located according to the sustainability and adaptation principles set out in the current National Planning Framework (NPF3). While some of the outcomes in the upcoming NPF4 may relate to resilient infrastructure, it remains to be seen whether these will be monitored closely enough to understand whether new infrastructure is designed and located to be resilient to climate change. There is also a lack of metrics or indicators against which to assess resilience of infrastructure to extreme weather events over time. This has been raised in both of the Committee's previous assessments of adaptation progress in Scotland.

* Relevant plans and policies relating to the design and location of new infrastructure are the National Planning Framework (NPF) and the Infrastructure Investment Plan (2021). The National Planning Framework is currently under review. A draft National Planning Framework 4 (NPF4) was published in November 2021 for consultation, with the final NPF4 expected in the second half of 2022.

9. Infrastructure interdependencies

Progress summary – Infrastructure interdependencies
Plan score: Low • There is no national assessment of the scale of current and future risks and weather-related cascading infrastructure failures due to interdependencies in Scotland and there is no plan in place to address it. • There are no specific policies, actions or risk owners in the SCCAP to address risks from interdependent infrastructure. **Risk management score: Low** • There is no evidence of the current exposure of interdependent infrastructure in Scotland to climate risks, and no evidence of actions being taken which will manage risks from interdependent infrastructure.
Relevant risks from CCRA3: • I1 Risks to infrastructure networks (water, energy, transport, ICT) from cascading failures More information on the related risks can be found in CCRA technical report chapter 4, Scotland National Summary.

a) Introduction

The interconnectedness of infrastructure systems can magnify the impacts of weather and climate impacts in one system across society.

All of the weather and climate related impacts on individual infrastructure networks discussed in this chapter are exacerbated by the interconnected nature of infrastructure. Failures of one infrastructure system can cause significant impacts in another due to the growing interdependence of infrastructure (e.g. a power outage affecting transport, communications, health or emergency services which rely on electricity to operate). These impact cascades can substantially increase the effects of weather-related infrastructure failure on society. Infrastructure will become increasingly interconnected in future through the increasing reliance on electricity to decarbonise much of the economy and increasing reliance on digital and ICT services across all infrastructure sectors.

Addressing the risks of cascading failures is one of the most urgent aspects of adaptation.

Risks to infrastructure networks from cascading failures are one of the most urgent risks identified in the Independent Assessment of UK Climate Risk (CCRA3). The assessment notes that significant governance barriers exist in dealing with cascading failures, which affect not only the level of preparedness of the infrastructure network, but also the type of response to failures and disruptions. The interconnectivity between the infrastructure assets means that any poorly defined responsibilities, or lack of coordination between various operators, could undermine the ability to anticipate, react and recover from cascading failures. Government can play a key role in adopting a system-based approach to planning for resilience by providing the information to enable this, and providing infrastructure operators with a regulatory framework that supports adaptation at network level rather than just at the level of individual assets.

b) Planning score

There is currently no national assessment or plan for infrastructure interdependency.

The quality of plans is assessed as **low.** There is no national assessment of the scale of current and future weather-related interdependency risk in Scotland and no plan in place to address it.

The SCCAP acknowledges interdependencies between infrastructure sectors and includes a range of actions to make individual infrastructure systems more resilient. Ensuring resilience of individual sectors is an important adaptation action to reduce the potential impact of cascade failures, and while there appears to be a framework in place for delivery of critical infrastructure resilience in Scotland, there are no specific plans or actions that target interdependencies between sectors.

Owners and operators of critical infrastructure are responsible for contingency planning at the asset level, but the extent to which this is mandated through legislation and incorporates future climate risks varies across sectors, as is set out in this chapter.

A system-wide approach is critical to addressing the risks from infrastructure interconnectedness.

The Infrastructure Commission for Scotland has identified that a system-wide approach is critical to moving beyond asset specific risk management and to identifying the key systemic interdependency risks.* The Commission has recommended Scottish Government should develop a clear implementation plan, to address critical natural and built infrastructure climate resilience and adaptation needs. In the Draft Infrastructure Investment Plan for Scotland 2021-22 to 2025-26, Scottish Government accepted that recommendation and referred to the Scottish Climate Change Adaptation Programme (SCCAP2) as evidence that they were implementing it.[16] However, SCCAP2 itself only references the forthcoming Infrastructure Investment Plan as one of the key cross-cutting policies to drive forwards adaptation in infrastructure. This creates a circularity and means that a clear implementation plan for infrastructure resilience is currently not being developed.

There is evidence of progress in planning for interdependency risks at a regional level, such as the Climate Ready Clyde project in Glasgow (Box 5.3).

Box 5.3
Case Study – Climate Ready Clyde & infrastructure Interdependencies

'Climate Ready Clyde', brings together stakeholders including Local Authorities, The Scottish Environment Protection Agency (SEPA), SGN, the NHS and Transport Scotland to develop Glasgow City Region's first Climate Adaptation Strategy. This strategy, currently in draft, outlines the processes and early interventions needed to manage climate risks, provides a strategic framework for adaptation, and sets out how the city will expand collaboration between citizens and organisations (Climate Ready Clyde, 2020). Through the partnership, these organisations have worked together on projects with infrastructure providers such as Scottish Water and Scottish Power Energy Networks to understand better regional interdependencies of infrastructure, producing new tools and assessments to deepen collective understanding. They have also produced a toolkit for assessing climate risk in the built environment and infrastructure projects. The toolkit includes a specific recommendation to consider cross-organisation risks and interdependencies.

* In 2019, the Scottish Government established an independent Infrastructure Commission for Scotland to support delivery of the National Infrastructure Mission and development of an Infrastructure Investment Plan. The Commission provides advice to the Scottish Government on infrastructure vision, ambition and priorities.

c) Risk management score

The management of climate risks is assessed as **low.** There are no data available to assess the management of the risk and CCRA3 found the risk to be high magnitude in Scotland. Storm Arwen has also highlighted the potential for cascading failures from infrastructure interdependencies.

- Risks to infrastructure networks from cascading failures are assessed as high magnitude for Scotland in all future climate scenarios in CCRA3. More action is needed to manage this risk, due to:
  - the lack of a systematic national assessment of interdependency risk
  - the poor assessment of progress on adaptation in this area, and
  - the low likelihood that sufficient non-governmental action will be undertaken.

Recent storms indicate the possibly wide-reaching impacts due to infrastructure interconnectedness.

- Storm Arwen showed infrastructure in Scotland is currently exposed to cascading failures resulting from infrastructure interdependencies. The extent and magnitude of this risk in Scotland is not fully known, and there is no evidence of actions being taken which will manage risks from interdependent infrastructure.

Endnotes

[1] Sayers, PB., Horritt, M, Carr, S, Kay, A, Mauz, J., Lamb R, and Penning-Rowsell E (2020) Third UK Climate Change Risk Assessment (CCRA3): Future flood risk. Research undertaken by Sayers and Partners for the Committee on Climate Change. Published by Committee on Climate Change, London

[2] Scottish Government (2020). *Scottish Water: directions 2020.* https://www.gov.scot/publications/scottish-water-directions-2020/

[3] Scottish Water (2015). *Water Resource Plan 2015 (Summary Report).*

[4] SEPA (2019). *Water Supply and Waste Water Sector Plan.*

[5] HR Wallingford (2020). *Technical Report, Updated projections of future water availability for the third UK Climate Change Risk Assessment*, RT002 R05-00. Report produced for Committee on Climate Change.

[6] Scottish Water (2021) *Annual Report & Accounts 2020/21: Performance and prospects.*

[7] Infrastructure Commission for Scotland (2020) Full Key Findings Report, available online at: https://infrastructurecommission.scot/storage/281/Phase1_FullReport.pdf

[8] Ardrossan Herald (2021) https://www.ardrossanherald.com/news/19743689.arran-ferry-sailings-cancelled-day-due-storm-arwen/

[9] Jaroszweski, D., Wood, R., and Chapman, L. (2021) Infrastructure. In: The Third UK Climate Change Risk Assessment Technical Report. [Betts, R.A., Haward, A.B., Pearson, K.V. (eds)] Prepared for the Climate Change Committee, London

[10] Dawson, R.J., Thompson, D., Johns, D., Gosling, S., Chapman, L., Darch, G. et al. (2016). UK Climate Change Risk Assessment Evidence Report: Chapter 4, Infrastructure. Report prepared for the Adaptation Sub-Committee of the Committee on Climate Change, London. https://www.theccc.org.uk/wp-content/uploads/2016/07/UK-CCRA-2017-Chapter-4-Infrastructure.pdf

[11] Jaroszweski, D., Wood, R., and Chapman, L. (2021) Infrastructure. In: The Third UK Climate Change Risk Assessment Technical Report. [Betts, R.A., Haward, A.B., Pearson, K.V. (eds)] Prepared for the Climate Change Committee, London

[12] Dawson, R.J., Thompson, D., Johns, D., Gosling, S., Chapman, L., Darch, G. et al. (2016). UK Climate Change Risk Assessment Evidence Report: Chapter 4, Infrastructure. Report prepared for the Adaptation Sub-Committee of the Committee on Climate Change, London. https://www.theccc.org.uk/wp-content/uploads/2016/07/UK-CCRA-2017-Chapter-4-Infrastructure.pdf

[13] Evidence for the third UK Climate Change Risk Assessment (CCRA3), Summary for Scotland, Sniffer, 2021. Available at: https://www.ukclimaterisk.org/wp-content/uploads/2021/06/CCRA-Evidence-Report-Scotland-Summary-Final-1.pdf

[14] TechUK (2021*) Sector Readiness for Climate Change Risks: Data Centres - Report to DEFRA under the Adaptation Reporting Power: Third Round.*

[15] Scottish Government (2021) *Green datacentres and digital connectivity: vision and action plan for Scotland.*

[16] Scottish Government (2020) *A National Mission with Local Impact, Draft Infrastructure Investment Plan for Scotland 2021-22 to 2025-2026.*

Chapter 6

Business

Summary of progress

Table 6
Progress summary - Business

Adaptation Priority	Plan Score	Risk Management Score
Extreme weather impacts on business	Medium	Low
Supply chain disruptions	Low	Low
Water demand by industry	Medium	Medium
Business opportunities from climate change adaptation	Low	Low

This chapter assesses progress in adapting businesses to climate risks.

This chapter considers progress by Scotland's businesses in adapting to climate change. Businesses can be affected by flooding and storms, coastal change due to erosion, risks of reduced water availability, higher temperatures in working environments and the risks from weather-related disruption of supply chains in Scotland and internationally. There are also some opportunities from a changing climate, including warmer summers leading to possible opportunities for increased tourism, improved growing conditions for agriculture and opportunities to provide goods and services to meet a growing need for adaptation across the economy. There are also risks of lock-in by businesses taking decisions that do not factor in climate change, such as on their site locations, operating models, infrastructure, supply chains and technology.

The key points from this assessment are:

- **There are good examples of regional and local plans for business risks**. For example, Glasgow City Region's Economic Strategy, incorporates the impacts of extreme weather on business.
- **The Scottish Environment Protection Agency (SEPA) encourages operators to minimise their water use but there are no measurable targets for reducing water demand by industry**. Abstraction data is also not published publicly.
- **Business opportunities from climate change are not being considered in relevant sector plans and strategies.** This is particularly the case outside of nature-based jobs and skills, and Historic Environment Scotland. For example, the tourism industry strategy does not include consideration of increased outdoor tourism as a result of warmer summers and milder winters.

- **Availability of data to measure progress by Scottish businesses remains limited for most of the priority areas in this chapter.** Several research proposals were scoped out but not taken forwards by the Scottish Government, limiting the information available for assessing progress. It is imperative that the availability of data is addressed, wherever possible working with relevant departments of the UK Government and other devolved administrations to ensure alignment and enable a consistent view of risks to UK businesses from climate change and their actions in response.

Recommendations for improving the quality of adaptation planning and the ability to manage the risks are set out in Table 6.1.

Table 6.1
Business recommendations

Priority Area	Recommendations
Extreme weather impacts on business	Integrate adaptation into plans for Scotland's recovery from Covid and the skills transition for Net Zero (see also the section on the Covid-19 Recovery in Scotland in Chapter 1) Fund work to design and populate indicators of Scottish businesses' preparedness and measure the impacts of extreme weather.
Supply chain disruptions	Ensure that adaptation is integrated into major upcoming policies in the next two years regarding risks to the supply of food, goods and vital services due to climate-related collapse of supply chains and distribution networks. Set out measures to ensure the resilience of the food supply chain, including to the risks of extreme weather in Scotland and internationally.
Water demand by industry	Establish a process for collecting and publishing data on abstraction by businesses. Collect data which can help confirm if reductions in water use are due to improved efficiency. Set out targets and supporting measures for reducing water use by business.
Business opportunities from climate change adaptation	Scottish Government should commission research assessing the opportunities from climate change to businesses and current barriers preventing businesses from realising these opportunities. The Blue Economy Action Plan should consider opportunities to the blue economy from climate change, including new fishing and tourism opportunities.

There are four priority areas assessed in this chapter:

1. Extreme weather impacts on business
2. Supply chain disruptions
3. Water demand by industry
4. Business opportunities from climate change adaptation

1. Extreme weather impacts on business

Progress summary – Extreme weather impacts on business
Plan score: Medium • There is new UK legislation for mandatory climate-related disclosures and examples of integrating adaptation into relevant plans such as Glasgow City Region's Economic Strategy. However, there are not clear, easily measurable objectives for managing extreme weather impacts on business. **Risk management score: Low** • Evidence for the UK published since 2019 suggests continued progress in some areas. • The impact of climate hazards on Scottish business is not currently measured and there are no updated data on business continuity planning. Proposed research to understand climate change risks for business has not been delivered.
Relevant risks from CCRA3: • B1 Risks to businesses from flooding • B2 Risks to businesses and infrastructure from coastal change • B4 Risks to finance, investment and insurance including access to capital for businesses • B5 Risks to business from reduced employee productivity due to infrastructure disruption and higher temperatures in working environments More information on the related risks can be found in CCRA technical report chapter 6, Scotland National Summary, Business Briefing.

a) Introduction

This adaptation priority covers extreme weather impacts on businesses in Scotland. Impacts include both direct damage to premises, as well as indirect impacts on the provision of goods and services, though weather-related disruptions to supply chains are not considered here, as these are addressed in the subsequent adaptation priority. The potential for overheating in work environments could impact on productivity and employee wellbeing, and staff may be unable to get to work during spells of extreme weather or flooding. The latest Independent Assessment of UK Climate Risk (CCRA3) found businesses are already vulnerable to a range of climate impacts. For example, the expected direct damages from flooding for non-residential properties in Scotland at present is £114m per year.[1] SEPA estimated 30,000 non-residential properties faced flood risk with a medium likelihood* and 10,000 non-residential properties faced flood risk with high likelihood†.[2] The impacts of recent extreme weather in 2021 and early 2022 in Scotland are still being understood. A review of the response to Storm Arwen by Scottish Government identified loss of power, loss of telecoms, loss of water supply, cancellation of train and ferry services and disruption to road travel.[3] Such impacts significantly affect businesses' ability to operate and there are clear interdependencies with the resilience of energy and transport infrastructure.

* defined as a 1 in 200 chance.

† defined as a 1 in 10 chance.

Relevant policy in this priority area is largely devolved to the Scottish Government in relation to activities affecting economic development, such as business support.

The UK single market for financial services means that Scottish financial services firms follow the same legal and regulatory system as the rest of the UK.

b) Planning score

The level of adaptation planning is scored as **medium**[*]**.** While there are some good examples of regional and local plans, an overarching plan for Scottish businesses is lacking. In particular, there are not clear, easily measurable objectives for managing extreme weather impacts on business. Without an overarching plan, the roles of Government and the role of the private sector in adapting to climate change will not be clear and business sectors may take different approaches which do not cohere. An overarching plan could provide businesses with greater certainty for planning and act as a single, trusted and reliable source of information. Decisions made today which are based on inadequate information risk 'lock-in' to negative impacts in the future and risk missing out on the opportunity to achieve long-term benefits by adapting now.

There are some good examples of regional and local plans for businesses to adapt to climate change.

- **Adaptation actions in plans.** There are some good examples of regional and local plans. Glasgow City Region published a Climate Adaptation Strategy and Action Plan which includes targets for 2025 to close its estimated adaptation finance gap of £184m a year and to involve 125 new organisations, community groups and businesses in supporting Glasgow City Region to adapt.[4] The 11 stated 'interventions' of the strategy also consider enabling businesses to adapt, making buildings such as offices resilient and transitioning the economy to one which is resilient to future climate impacts. As part of the Scotland Loves Local campaign, grants are being distributed to businesses and development organisations to support local economies affected by the Covid-19 pandemic.[5] Successful bids have included promoting sustainable tourism and tackling the impacts of flooding in urban areas. Many large Scottish businesses will also disclose information on climate risk and adaptation actions as part of new UK legislation for mandatory climate-related disclosures. In the 2020-2021 Programme for Government the Scottish Government committed to the development of a Blue Economy Action Plan which has not yet been published.

- **SMART objectives.** There is a UK roadmap for mandatory climate-related disclosures which includes timescales for when large business must report.[6] However, there need to be clear plans and support for smaller businesses and measures to ensure that approaches to considering physical risk continue to progress. In addition to this, plans for financing are needed to ensure that adaptation can take place, including actions by Government to encourage investment by the private sector. Among its recommendations following COP26, the Climate Emergency Response Group recommended that 'initiatives such as the Green Growth Accelerator, and others developed through the Scottish National Investment Bank, have strict criteria and monitoring to ensure every business plan delivers significant climate emission reductions and supports

[*] Relevant strategies and policies relating to extreme weather impacts on business are: Scotland's Economic Strategy (2015); Scotland Loves Local programme (2021); Glasgow City Region Economic Strategy (2021); Economic Commitments in the Programme for Government 2021/22; Guidance and Services from Adaptation Scotland; UK Companies (Strategic Report) (Climate-related Financial Disclosure) Regulations 2021; and Blue Economy Action Plan (To be developed).

adaptation to climate risks'.[7] Overall, there are not clear, easily measurable objectives for managing extreme weather impacts on business.

The Climate Emergency Response Group also made several recommendations to try and 'solve real and specific financing challenges to secure private sector investment' with 'incubator' projects to help identify financing mechanisms and models for sectors such as adaptation and resilience, nature-based solutions, city and local infrastructure, energy efficiency and housing.

Financing for adaptation remains a challenge which is not being adequately addressed in Scottish Government plans.

Climate Xchange published research in March 2021 on 'International practice on assessing investment needs and securing investment to adapt' with particular emphasis on flood risk management, coastal change and coastal erosion. It is not clear how this or other research findings are being incorporated into plans to ensure there is finance for adaptation across Scotland.

c) Risk management score

The management of extreme weather impacts on business is scored as **low**. Evidence for the UK published since 2019 suggests continued progress in some aspects of climate-related reporting, such as the number of companies reporting regularly, the overall quality of reporting and better approaches to assessing physical risk which consider 4°C or higher climate change scenarios.[8] However, in other aspects such as disclosure of the potential financial impact of climate change on businesses and their strategies, metrics for assessing physical risk and stating adaptation actions in response, there is very limited progress.

There is a data gap for assessing physical risk to businesses.

The availability of Scotland-specific indicators focussed on physical risk and adaptation for this priority remains limited and there is little new information on the economic impacts of extreme weather.

- **Indicators for this area have not been developed.** Proposed research projects to improve the understanding of climate change risks for businesses in Scotland have not been delivered. A different piece of research was published by Climate Xchange in September 2021 on 'Measuring recovery from extreme weather events' which made suggestions regarding indicators, including some for business.[9] However, it is not clear how the findings from this research are being taken forward. As a result, the impact of climate hazards on business is not currently measured and there are no updated data on business continuity planning.

Progress summary – Supply chain disruptions
Plan score: Low • There is no overarching plan to address climate risks to Scottish businesses' supply chains although there is some support for supply chain resilience more generally. **Risk management score: Low** • Recent survey data for the UK indicates high costs from supply chain disruptions and specific data for Scottish businesses was not available.
Relevant risks from CCRA3: • B6 Risks to business from disruption to supply chains and distribution networks • ID1 Risks to UK food availability, safety, and quality from climate change overseas • ID7 Risks from climate change on international trade routes More information on the related risks can be found in CCRA technical report chapter 6 and 7, Scotland National Summary, Business Sector Briefing.

a) Introduction

This adaptation priority covers disruptions to supply chains from climate hazards, for example, flooding, storms and drought. Some sectors and organisations are more exposed to climate hazards through their supply chains than others. For example, businesses in the food sector rely on agriculture which is particularly exposed to a changing climate and has long distribution networks, with 50% of food consumed* in the UK imported from 180 different countries.[10] Climate change is likely to contribute to an increase in exposure to supply chain disruption, with some businesses already reporting that weather and climate hazards are a driver of future supply chain risks.

Climate change is likely to cause supply chain disruption both in the UK and overseas which can affect Scottish businesses.

There are limited data available on the risks to Scottish businesses from climate-related disruption to supply chains.

Risks to businesses outside of supply chain disruption are covered in Business Impacts from Extreme Weather.

Relevant policy in this priority area is largely devolved to Scottish Government which has responsibility for supporting businesses and innovation. In some sectors, notably marine and fishing, certain areas are not devolved. Please see the sections Marine and Coastal Habitats and Species and Commercial Fisheries and Aquaculture for more detail on devolution relating to those areas. The UK Agriculture Act 2020 requires a report every three years on food security in the UK.

* Measured by economic value.

b) Planning score

The level of adaptation planning is scored as **low** *. There is no overarching plan to address climate risks to Scottish businesses' supply chains. There is some support for supply chain resilience more generally.

Support to businesses around supply chain disruption is mostly related to the UK exiting the EU, not to climate risks.

- **Adaptation actions in plans.** Scottish Enterprise offers support to businesses around supply chain disruption, although this is largely related to disruption from the UK exiting the EU. In Scottish Enterprise's 2021/2022 Business Plan, supporting business resilience is included as an objective, but without specific mention of climate risks to supply chains. Climate change is mentioned in the plan, but only in relation to achieving Net Zero.

c) Risk management score

The management of supply chain disruptions due to climate change is scored as **low**. Recent survey data for the UK indicates high costs from supply chain disruptions but specific data for Scottish businesses were not available.

- **A 2021 assessment found that the costs of supply chain disruptions in the UK are significant.** The Economist Intelligence Unit assessed the business costs of supply chain disruption (from all causes, including weather-related disruption) in the UK, finding that financial costs have averaged 6-10% of annual revenues. There have also been reputational costs in terms of customer complaints and damage to brand reputation.[11]

The cost of supply chain disruptions in the UK are already significant and survey respondents expect these costs to increase in future.

- **Other recent survey data suggest mixed progress on responses of businesses to supply chain risks.** CDP's Supply Chain Survey in 2020 found that UK Respondents expect $2.2 billion of increased costs over the next five years due to climate change, deforestation and water insecurity risks in their supply chains.[12]

- **The UK food security report found that the UK is broadly resilient to potential shocks in the food supply chains** and supply systems are adaptable and flexible in responding to problems. The report also recognises notable risks to food supply chains stemming from dependence on other critical sectors including energy, transportation, orders, labour, key components, and data communications.[13]

- **No specific data were available for supply chain disruptions to Scottish businesses.**

* Relevant strategies and policies relating to supply chain disruptions are: Scotland's Economic Strategy (2015); and Guidance and Services from Scottish Enterprise. Scottish Enterprise is Scotland's national economic development agency, a non-departmental public body of the Scottish Government.

3. Water demand by industry

Progress summary – Water demand by industry
Plan score: Medium • There are stated goals to encourage businesses to reduce their water use and design business premises for low water use. Some plans do not use the latest climate change projections and there are no measurable targets for reducing water demand by industry. **Risk management score: Medium** • Data are not available to assess trends in water abstraction by industry. Non-household consumption of the public water supply has decreased though it is not possible to assess if this is attributable to water efficiency measures.
Relevant risks from CCRA3: • B3 Risks to businesses from water scarcity More information on the related risks can be found in CCRA technical report chapter 6, Scotland National Summary, Business Briefing.

a) Introduction

This adaptation priority covers water demand by industry in Scotland. Water is used by industry for cooling and heating, washing products, dissolving chemicals, suppressing dust, and also as a direct input to products. Although Scotland is a relatively water rich country, water supply is likely to become increasingly stressed in the future under the combined effects of climate change and a growing population. Alongside increasing the supply of water, reducing demand by businesses and planning for future water scarcity and droughts can help to avoid the large potential costs to households, agriculture, energy generation, businesses and the environment, from not enough water being available today and in the future.

Water supply in the future is likely to become increasingly distressed.

Analysis in the latest Independent Assessment of UK Climate Risk (CCRA3) projects that some of the catchments in Scotland are unable to meet their environmental flow requirements without the addition of discharges to the river network in the mid and late-century, assuming a policy to keep environmental flows fixed at the same absolute volume that they are today.[14] This is in addition to pressures on the public water supply (see also Public Water Supply Infrastructure). Non-household demand is approximately 20% of the current demand for the public water supply in Scotland.

Relevant policy in this priority area is devolved to the Scottish Government. The Water Resources (Scotland) Act 2013 makes it a statutory duty for Scottish Ministers to 'take such reasonable steps … for the purpose of ensuring the development of Scotland's water resources'. Abstractions are regulated by the Water Environment (Controlled Activities) (Scotland) Regulations 2011 (CAR) and their further amendments, and these are monitored and enforced by the Scottish Environment Protection Agency (SEPA). Non-household customers in Scotland can choose their supplier of the public water supply.

b) Planning score

The level of adaptation planning is scored as **medium***. There are aspirations and some high-level planned actions for businesses to use water more efficiently. However, there are no measurable targets for reducing water demand by industry and a lack of specific measures to achieve reductions.

- **Adaptation actions in plans**. SEPA's Water Supply and Waste Water Sector Plan sets out actions and aspirations for using water efficiently.[15] This includes working with partners to encourage investment and support collaborative programmes which enable businesses to prevent water being wasted and ensure that business premises are designed so that achieving low drinking water use requires no extra effort. In Scotland's National Water Scarcity Plan, SEPA 'strongly encourage operators to minimise water use as far as possible … and draw up contingency plans for managing resources during periods of water scarcity to minimise the impact upon their business.[16] The plans should also look ahead to build in resilience to possible effects of climate change.'

There are some plans which encourage reduced water use by businesses but there are no targets for reducing water demand from industry.

- **SMART objectives.** There are no measurable targets for reducing water demand by industry. There is also a lack of specific measures to achieve reductions. Some plans (for example, Scotland's National Water Scarcity Plan) make reference to the previous UK Climate projections, UKCP09, and not to UKCP18.

c) Risk management score

The management of climate risks to water demand by industry is scored as **medium**. Data are not available to assess trends in water abstraction by industry. Non-household consumption of the public water supply has decreased though it is not possible to assess if this is attributable to water efficiency measures.

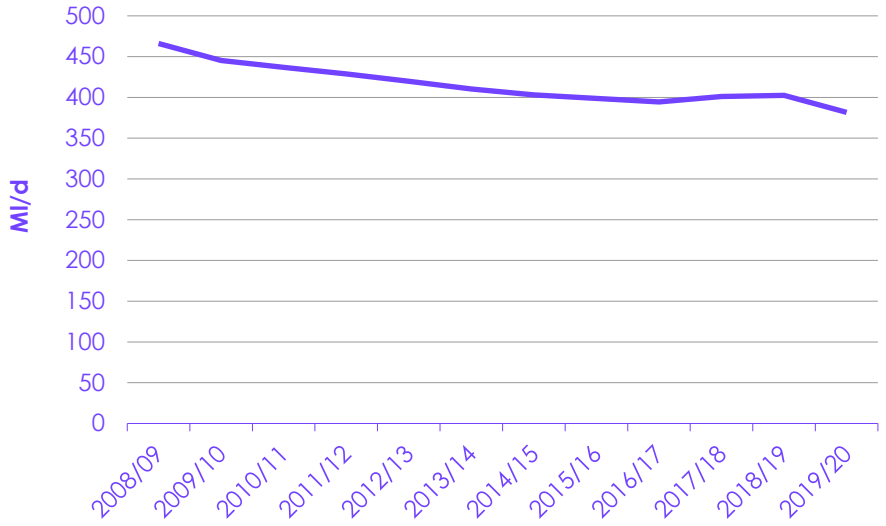
- **Water abstraction data by industry are not available.** Data are not available to assess trends in water abstraction by industry. SEPA had previously advised that it was establishing a process to publish data on water abstraction by industry in Scotland.

Data on water abstraction is not published publicly so it is not possible to assess trends in water use by industry.

- **Non-household consumption of the public water supply has decreased.** Non-domestic water consumption has continued to decrease in Scotland (Figure 6.1). However, since it is the absolute quantity of water that is reported rather than water use per unit of production, it is not possible to be definitive as to whether this is due to genuine improvements in efficiency rather than changes in production levels. There has been a decrease in the annual average volume of non-domestic water delivered per day between 2008/09 (466 Ml/d) and 2019/20 (381 Ml/d). However, there had been a small increase in consumption between 2016/17 (394 Ml/d) and 2018/19 (403 Ml/d). In 2019/20, 96% of non-household water delivered in Scotland was to properties with a meter.

* Relevant strategies and policies relating to water demand by industry are: Scottish Water's Performance (2021), Scottish Water Delivery Plan 2021-22 to 2022-23 (2021), Scotland's National Water Scarcity Plan (2020), Scottish Water's Strategic Plan - Sustainable Future Together (2020), Scotland: The Hydro Nation - Annual Report (2020), SEPA's Water Supply and Waste Water Sector Plan (2019).

Figure 6.1 Total non-household water delivered (including losses)



Source: Water Industry Commission for Scotland (2021) *Scottish Water's Annual Returns*

4. Business opportunities from climate change adaptation

Progress summary – Business opportunities from climate change adaptation
Plan score: Low • There is no overarching plan to manage opportunities for Scottish businesses from climate change adaptation. Key sector plans and strategies which could incorporate opportunities for businesses from climate change adaptation do not include relevant adaptation actions. • Historic Environment Scotland and NatureScot have published good plans which recognise opportunities from adapting to climate change **Risk management score: Low** • There is insufficient evidence available on opportunities to businesses from climate change in Scotland and previous research proposals to fill data gaps have not been taken forward by Scottish Government.
Relevant risks from CCRA3: • B7 Opportunities for business from changes in demand for goods and services • ID2 Opportunities for UK food availability and exports from climate impacts overseas More information on the related risks can be found in CCRA technical report chapter 6, Scotland National Summary, Business Sector Briefing.

a) Introduction

This adaptation priority covers opportunities to businesses from climate change. Production costs and demand for certain goods and services will be affected by climate change, increasing profitability in some cases, and decreasing in others. The adaptation services sector in the UK is also an opportunity for growth. CDP reported that 225 companies had identified $236 billion in revenue globally from the provision of adaptation goods and services.[17]

There are opportunities for business from adaptation to climate change across sectors such as agriculture, tourism, consulting, and finance.

A range of UK-wide opportunities are included in the latest Independent UK Climate Change Risk Assessment, including in agriculture, forestry, marine, shipping, seafood, construction, retail, tourism, climate advisory, consulting accounting services, finance and heritage. It should be noted that most of these opportunities are coupled with risks as well. For example, in order to take advantage of new forms of food production, risks related to land use change need to be managed.

Risks to businesses from climate change are covered in Business Impacts from Extreme Weather and Supply Chain Disruptions.

Relevant policy in this priority area is largely devolved to Scottish Government which has responsibility for supporting businesses and innovation. In some sectors, notably marine and fishing, certain areas are not devolved. The sections Marine and Coastal Habitats and Species and Commercial Fisheries and Aquaculture cover more detail on devolution relating to those areas.

b) Planning score

The level of adaptation planning is scored as **low***. Key sector plans and strategies which could see opportunities for businesses do not include actions or initiatives to manage these. Historic Environment Scotland and NatureScot have published good plans which recognise opportunities from adapting to climate change, but these alone are not enough to increase the overall planning score.

NatureScot has identified different types of jobs and skills related to tackling climate change and produced a plan to support these.

- **Adaptation actions in plans.** The national tourism strategy, Scotland Outlook 2030 Responsible Tourism for a Sustainable Future (2020), mentions climate change as a threat to society but does not explicitly consider the opportunities for the tourism industry in Scotland. Historic Environment Scotland, which contributes to the tourism sector through its management of Scotland's heritage, published a Climate Action Plan for 2020-2025. The plan sets out a range of actions across different areas, including for climate impacts and adaptation. It also states that 'adapting to the impacts of climate change and becoming 'climate ready'; is full of opportunity' and that these opportunities include 'exploration of new and innovative income streams.' In the 2020-2021 Programme for Government the Scottish Government committed to the development of a Blue Economy Action Plan. The plan is under development but, among other things, will aim to enhance the marine environment; create fairer and greener supply chains; enhance marine tourism, sea fisheries, the aquaculture sector and coastal communities; and improve the resilience of communities, supply chains and businesses. NatureScot published a Nature-based Jobs and Skills Action Plan 2021-2022 in August 2021 which identifies specific actions for NatureScot that can add value to support nature-based jobs and skills. It references climate and biodiversity crises and includes support for cross-cutting climate initiatives, for example, peatland restoration and woodland restoration, although it does not explicitly discuss jobs and skills needed to realise opportunities from future climate change. NatureScot is also supporting apprenticeships, student and graduate placements through its Programme for Youth Employment, some of which may be within climate adaptation. There has also been some initial exploration of opportunities from finance related to adaptation in regional plans and other assessments for Scotland (see also Extreme weather impacts on business).

- **SMART objectives.** The Nature-based Jobs and Skills Action Plan has SMART objectives, although over a limited one-year timeframe which would need further plans to have long-term impact. Historic Environment Scotland's Climate Action Plan sets out a range of specific actions over the next five years, some with measurable deliverables such as producing new guidance or including resilience measures in its investments and grants.

- **Monitoring and evaluation.** The Nature-based Jobs and Skills Action Plan will be reviewed at the end of its one-year period and if there are sufficient resources, a further three-year plan will be developed, incorporating the progress from the first year. Historic Environment Scotland has set up a Climate Action Plan Governance Board, to be chaired by its Chief Executive, which will monitor delivery of actions in the plan over the next five years.

* Relevant strategies and policies relating to business opportunities from climate change are: Scotland Outlook 2030, a new tourism industry strategy published in 2020; Historic Environment Scotland's Climate Action Plan 2020-2025; Nature-based Jobs and Skills Action Plan; and the Blue Economy Action Plan (to be published).

Adaptation Scotland supports organisations and businesses to prepare for climate change.

The Scottish Government also funds the Adaptation Scotland programme to help organisations, businesses and communities to understand what climate change will mean for them. Adaptation Scotland provides ongoing support across:

- Leadership and policy, including supporting external events like the National Climate Resilience Summit
- Place-based adaptation, including establishing initiatives across cities, regions and islands, for example Highland Adapts
- Knowledge and innovation, including working with organisations to progress adaptation in their work and developing the adaptation capability framework

c) Opportunity management score

The management of climate opportunities to businesses is scored as **low**. There is insufficient evidence available on opportunities to businesses from climate change in Scotland.

Research is needed to understand the scale of the opportunity in Scotland for businesses to adapt to climate change.

- **Absence of data.** There are currently no data available to assess the extent to which opportunities are being managed for businesses. This lack of data was highlighted in the previous SCCAP assessment as well.
- **Research was not taken forward to understand opportunities.** Research on the size of the opportunity to Scotland's economy was underway in 2018 with a paper on 'Scoping and Sizing the Scottish Adaptation & Resilience (Climate Change) (A&RCC) Economy: An overview of methods' but this research project was not included in SCCAP2 or ultimately taken forward.
- **NatureScot have identified that the nature-based sector provides 195,000 jobs in Scotland and that nature-based jobs grew at more than five time the rate of all jobs in Scotland from 2015-2019.** [18] The study anticipated significant further growth in the sector as activities to meet Net Zero targets grow. It did not separate out opportunities for adaptation activities specifically, but woodland and peatland restoration have clear benefits for both climate change mitigation and adaptation.

Endnotes

[1] Sayers, P.B., Horritt, M.S, Carr, S, Kay, A, Mauz, J, Lamb, R and Penning-Rowsell, E. (2020). Third UK Climate Change Risk Assessment (CCRA3) Future flood risk: Main Report. Retrieved from https://www.ukclimaterisk.org/wp-content/uploads/2020/07/Future-Flooding-Main-Report-Sayers-1.pdf

[2] SEPA (Scottish Environment Protection Agency) (2018). *National Flood Risk Assessment (NFRA) and Potential Vulnerable Areas (PVAs) and Flood Maps.*

[3] Scottish Government (2022) *Storm Arwen Review*. Retrieved from: https://www.gov.scot/publications/storm-arwen-review/

[4] Climate Ready Clyde (2021) *Glasgow City Region Climate Adaptation Strategy and Action Plan.*

[5] Scotland Loves Local (2021) *Scotland Loves Local Fund supports sustainable local initiatives.* Retrieved from: https://lovelocal.scot/scotland-loves-local-fund-supports-sustainable-local-initiatives/

[6] HM Government (2021). *Greening Finance: A Roadmap to Sustainable Investing.*

[7] Climate Emergency Response Group (2021) *Delivering on Scotland's response to the climate emergency: 12 immediate actions for the new Scottish Government in the year of COP26.*

[8] TCFD (2020) *2020 Status Report.*

[9] Orr, P. et al. for Climate Xchange (2021) *Measuring recovery from extreme weather events.*

[10] Surminski, S. (2021) *Business and industry.* In: The Third UK Climate Change Risk Assessment Technical Report [Betts, R.A., Haward, A.B. and Pearson, K.V. (eds.)]. Prepared for the Climate Change Committee, London.

[11] Economist Intelligence Unit (2021) *The Business Costs of Supply Chain Disruption*.

[12] CDP (2021) *Transparency to Transformation: A Chain Reaction CDP Global Supply Chain Report 2020.*

[13] Defra (2021) *United Kingdom Food Security Report 2021.*

[14] HR Wallingford (2020) *Updated projections of future water availability for the third UK Climate Change Risk Assessment Technical Report*.

[15] SEPA (2019) *Water Supply and Waste Water Sector plan.*

[16] SEPA (2020) *Scotland's National Water Scarcity Plan.*

[17] CDP(2019) *Major Risk or Rosy Opportunity: Are companies ready for climate change?*

[18] NatureScot (2020) *Nature-based jobs and skills for net zero – an initial assessment.*

March 2022

Is Scotland climate ready?
2022 Report to Scottish Parliament

Climate Change Committee
1 Victoria Street
Westminster
SW1H 0ET

www.theccc.org.uk
@theCCCuk

Climate Change Committee