Committee on Climate Change

Scottish Climate Change Adaptation Programme: An independent assessment for the Scottish Parliament

Committee on Climate Change
September 2016

Acknowledgements

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Contents

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Foreword

Scotland's unique geography creates both resilience and vulnerabilities to the impacts of extreme weather and climate change. Scotland has both very densely and sparsely populated areas that will be exposed to heightened flood risks and higher average and extreme temperatures. Sea level rise will affect Scotland's coastline and its many inhabited islands. Scotland's iconic industries including timber and whisky, and its fisheries, rely on the abundance of climate-sensitive natural resources. Many remote communities depend on exposed, ageing infrastructure, whilst their private water supplies and locally generated power provide resilience but also vulnerability in the changing climate.

The projected changes in weather patterns combined with sea level rise will test the nation's transport, communication, fuel and energy networks and challenge the delivery of health and social care services. There will also be opportunities for Scottish businesses investing in the products, services and new technologies that will be needed to adapt urban areas and grow rural economies in Scotland. The natural environment in Scotland will change as species shift northwards, and to higher ground, resulting in the loss of some species but gains in others. Longer growing seasons, increased CO_2 fertilisation and the current availability of freshwater may increase agricultural and forestry production if not limited by the quality of soils and the impact of pests and diseases in a warmer, wetter climate.

This report presents the first statutory assessment of the steps being taken to prepare Scotland for climate change. It considers both the risks and the opportunities. In 2014, the Scottish Government requested this independent progress report be presented to Parliament. It will inform proposals and policies being considered and guide efforts to plan a suitable response for Scotland to climate change.

Our assessment shows that the first SCCAP provides a solid foundation for further progress. Many policies and plans already take account of climate change and, based on the feedback received by the Adaptation Sub-Committee, commitments within the programme are being fulfilled. But we found a number of evidence gaps in important areas that means it is difficult to determine at this stage whether key vulnerabilities are being suitably addressed. The existence of the SCCAP in itself is an important step, and its focus on developing evidence and building capacity in key organisations is welcome and necessary. But looking forward there is a need for more adaptation action: specific, effective steps to directly confront and tackle the risks highlighted. More could also be done to make sure Scotland is ready to realise the opportunities that milder winters and warmer summers will bring.

Policymakers in Scotland will also need to consider how best to respond to the recent UK referendum result in favour of leaving the European Union. Many of the key policies discussed in this report are derived from European legislation, with sanctions and financial penalties if they are not achieved. If such policies are repealed they will need to be replaced in order to ensure progress with adaptation continues to be made.

Professor Lord Krebs Kt FRS
Chair, Adaptation Sub-Committee of the Committee on Climate Change

Key messages

Scotland needs to prepare for the impacts of climate change. The climate in Scotland has already warmed and become wetter and further changes are inevitable in the coming decades due to greenhouse gases from human activity already released to the atmosphere. The Paris Agreement should mark the turning point in the global action needed to limit further warming. Otherwise temperature increases of 4°C or more by the end of the century would remain possible. Even two degrees of warming is associated with severe, pervasive and irreversible impacts for people and the natural environment.

The first Scottish Climate Change Adaptation Programme (SCCAP), published in May 2014, was a significant first step to bring together existing policies and activities into a more coherent programme. Moving forward, it could be improved in terms of its coverage, governance and impact. The second SCCAP due in 2019 should include timescales for actions to be completed and clearer ownership of objectives. More data are needed to monitor risks, assess progress in the implementation of policies, and inform future adaptation decisions.

Across the three themes of the SCCAP, policies and plans are generally in place and, other than in a few isolated cases, actions are taking place. However, evidence of progress being made is mixed. There was insufficient evidence to judge progress in many of the areas assessed.

- **Natural environment:** Many species are already shifting their ranges in response to warmer conditions. However, the capacity of species and ecosystems to adjust and adapt to climate change is threatened by habitat loss and fragmentation, pollution of land, air and water, over-exploitation of resources, and the spread of invasive species and pathogens. The resilience of Scotland's natural environment could be enhanced by further effort to restore peatlands and native woodlands, tackle diffuse pollution and over-abstraction of water, protect agricultural soils, and safeguard Scotland's forests against pests and diseases. Changes at the base of the marine food chain due to higher sea temperatures and ocean acidification have potentially far-reaching implications for Scotland's fisheries and marine wildlife, and warrant more research and early policy consideration.
- **Buildings and infrastructure networks:** Action is being taken to reduce the vulnerability of communities to flooding and to improve infrastructure performance in extreme weather. However, there are limited data at a national scale to determine how much progress is being made. There is therefore an urgent need to review whether current actions are sufficient to manage long-term risks from flooding and extreme weather, the impacts of which can otherwise be expected to increase. Development in the floodplain, along with ongoing increases in impermeable surfacing, is likely to be adding to long-term costs and risks due to weaknesses in how planning policy is being implemented.
- **Society:** Considered in isolation, milder average winters will reduce the burden of cold weather on people, infrastructure and the health and social care system. However, due to the growing, ageing population the number of premature deaths in cold weather is not expected to fall significantly. More needs to be done to improve the performance of Scotland's housing stock so that peoples' health and wellbeing is protected in cold winters as well as in hotter summers. Support and guidance is available to businesses looking to manage climate risks but more could be done to encourage companies to exploit the new markets and opportunities that could arise in the changing climate.

Table ES.1: Assessment of adaptation priorities in the Scottish Climate Change Adaptation Programme

Theme	Adaptation priority	Is there a plan?	Are actions taking place?	Is progress being made?
Natural environment (Chapter 2)	Terrestrial species and habitats	Green	Amber	Amber
	Freshwater rivers and lochs	Green	Amber	Amber
	Marine and coastal ecosystems	Amber	Amber	Amber
	Soils and agriculture	Amber	Green	Red
	Forestry	Green	Green	Amber
Buildings & infrastructure networks (Chapter 3)	Flooding and coastal erosion risk management	Amber	Green	Amber
	Surface water and sewer flooding	Green	Green	Amber
	Development in flood risk areas	Green	Red	Grey
	Resilience of buildings to extreme wind and rain	Amber	Green	Amber
	Water demand in the built environment	Green	Green	Amber
	Design and location of new infrastructure	Green	Amber	Grey
	Resilience of infrastructure services:	Green	Amber	Grey
	– Energy networks - generation, transmission and distribution	Green	Amber	Green
	– Public water supply	Green	Green	Amber
	– Ports, airports and ferry services	Amber	Amber	Grey

Table ES.1: Assessment of adaptation priorities in the Scottish Climate Change Adaptation Programme

Theme	Adaptation priority	Is there a plan?	Are actions taking place?	Is progress being made?
	– Roads and the rail network	Amber	Green	Green
	– Digital infrastructure	Amber	Grey	Grey
	Infrastructure interdependencies	Green	Amber	Grey
Society (Chapter 4)	Health and social care services	Amber	Green	Grey
	Emergency planning and response	Green	Green	Grey
	Recovery from extreme weather events	Amber	Amber	Grey
	Resilience of the population to changes in temperature	Amber	Green	Amber
	Resilience of people to pathogens, air pollution, UV radiation	Amber	Green	Grey
	Public understanding of climate related risks	Green	Green	Grey
	Business impacts from extreme weather	Amber	Green	Amber
	Business opportunities from climate change	Amber	Amber	Amber
	Supply chain disruptions	Amber	Amber	Amber
	Water demand by industry	Amber	Green	Grey

Notes:
- **Red**: plans and policies, delivery of actions, or progress in addressing vulnerabilities, are lacking.
- **Amber**: adaptation priority has been partially addressed, evidence of progress in some areas.
- **Green**: plans are in place, actions are being delivered, progress is being made.
- **Grey**: insufficient evidence to form a judgement.

Executive summary

Climate change in Scotland

Climate change is affecting Scotland now, with increases in seasonal temperatures, sea level and annual rainfall all being observed. At least some further warming of the climate is inevitable, and severe and disruptive changes in the climate this century cannot be ruled out.

Average temperatures in Scotland have increased in line with global trends, with average annual temperatures around 0.7°C higher than they were a century ago. Annual rainfall over Scotland has increased since the 1970s, to a level 13% above the average for the early decades of the 20th century. All seasons contribute to the increase in rainfall. Long-term monitoring of sea level at stations around the UK including Aberdeen shows the mean sea level for 2006 - 2008 was more than 100mm higher than during the 1920s.

The Evidence Report for the second UK Climate Change Risk Assessment (CCRA2), published in July 2016, highlighted the need for more action to manage flood risks, the potential for water scarcity, heat-related impacts on health and wellbeing, risks to the natural environment, and risks of food price volatility. More research is also needed to understand new and emerging pest and disease risks, especially for Scotland's forestry industry.

Cost-effective steps should be taken to prepare Scotland for the impacts of climate change. At the same time, Scotland must continue to play a role as part of the global effort to reduce greenhouse gas emissions and limit the potential for further warming.

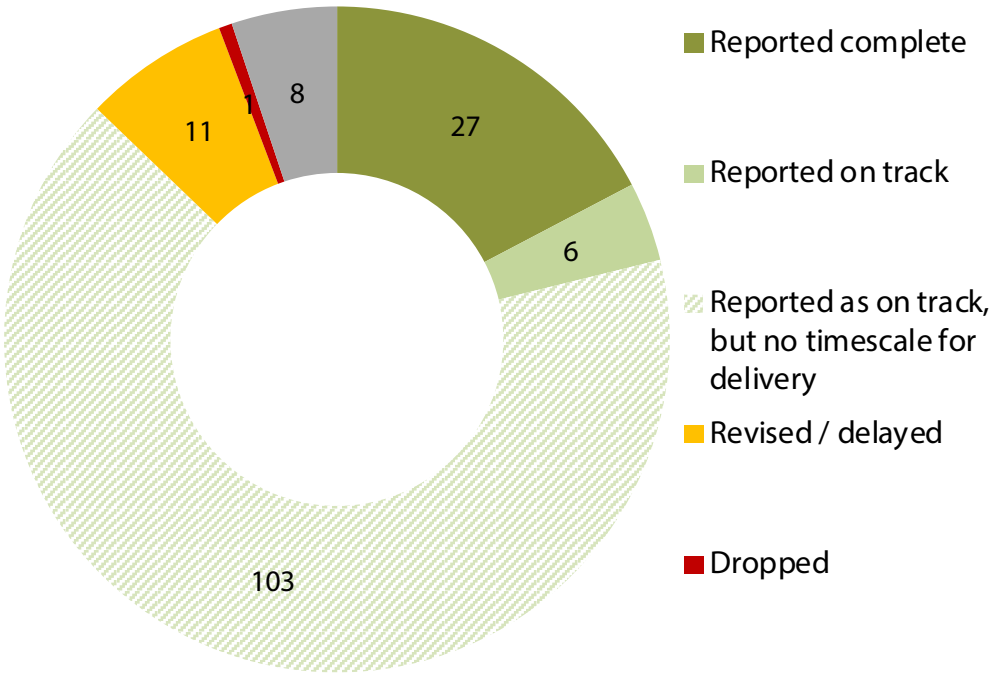
The Paris Agreement commits its 195 signatories to a process that aims to achieve net zero greenhouse gas emissions in the second half of the century. This would reduce but not remove the risk of dangerous levels of warming. Very few countries have yet made commitments in line with achieving zero net emissions. Commitments to date imply considerably more than 2°C of warming by 2100 (with a central estimate of 2.7°C), with up to 6°C remaining possible.

The Scottish Climate Change Adaptation Programme

The first SCCAP is a positive start and summarises current policies and plans to prepare Scotland for climate change. Objectives in support of climate change adaptation are established in each of the SCCAP's three themes, and almost all of the 148 policies and proposals mentioned in the programme are reported to be completed or "on track".

The Adaptation Sub-Committee's assessment of the SCCAP combines evidence from several sources. These include recent work by ClimateXChange - Scotland's centre of climate change science expertise - to develop datasets in key areas. Evidence also comes from the latest progress report by the Scottish Government on implementing the SCCAP, backed up by the ASC's own analysis and datasets collated in preparing CCRA2. The status of individual policies and proposals presented in the Scottish Government's latest progress report (Figure ES.1) is based on self-reporting by their owners in the relevant government departments and delivery agencies.

Figure ES.1: Status of policies and proposals in the Scottish Climate Change Adaptation Programme



Source: Scottish Government (2016) Climate Ready Scotland: Scottish Climate Change Adaptation Programme, Second Annual Progress Report.
Notes: The status of each policy or proposal is based on self-reporting by those responsible for their delivery.

Having assessed the first SCCAP and the individual policies and proposals within it, the ASC recommends the Scottish Government in preparing the second iteration due in 2019 should:

- **Address all of the urgent risks and opportunities for Scotland.** Around a third of the climate change risks and opportunities identified for Scotland in the first CCRA were not addressed in the first SCCAP. Unaddressed risks included potential impacts on priority natural habitats due to coastal erosion, biodiversity risks in warmer rivers, lochs and other freshwater bodies, and the potential for disruption to telecoms and other digital infrastructure.
- **Identify a senior owner for each objective to be held accountable for its delivery.** Whilst delivery of the SCCAP is overseen by a team in the Scottish Government, individual objectives are currently shared between different parts of government without clear ownership and accountability for achieving them.
- **List the specific actions that will be taken to achieve each objective together with appropriate milestones and timescales.** The first SCCAP focuses on evidence-gathering and other enabling measures, with less emphasis on taking action to address risks. Building the evidence base, and adaptive capacity, are necessary and important steps but by themselves are unlikely to lead to the risks from climate change being effectively managed.

- **Introduce an effective monitoring regime, to allow the impact of actions and delivery of each objective to be properly assessed.** The current SCCAP objectives are phrased in ways that make it difficult to measure whether they are being achieved. Of the 109 "on track" policies and proposals in the SCCAP only six have timescales associated with them.
- **Present the actions being taken within each sector together and co-ordinate their delivery.** Sector-specific activity is fragmented across several SCCAP objectives, risking a lack of co-ordination and delivery. For example the water sector has relevant policies and proposals discussed under all three SCCAP themes.

Progress in preparing for climate change in Scotland

Considering the individual policy areas in turn, progress is being made in some cases, whilst in others stronger policies or more co-ordinated and effective implementation is needed to address the risks and opportunities from climate change.

To evaluate the progress being made by the Scottish Climate Change Adaptation Programme, the Adaptation Sub- Committee has considered three questions in each of the areas identified as a priority for adaptation.

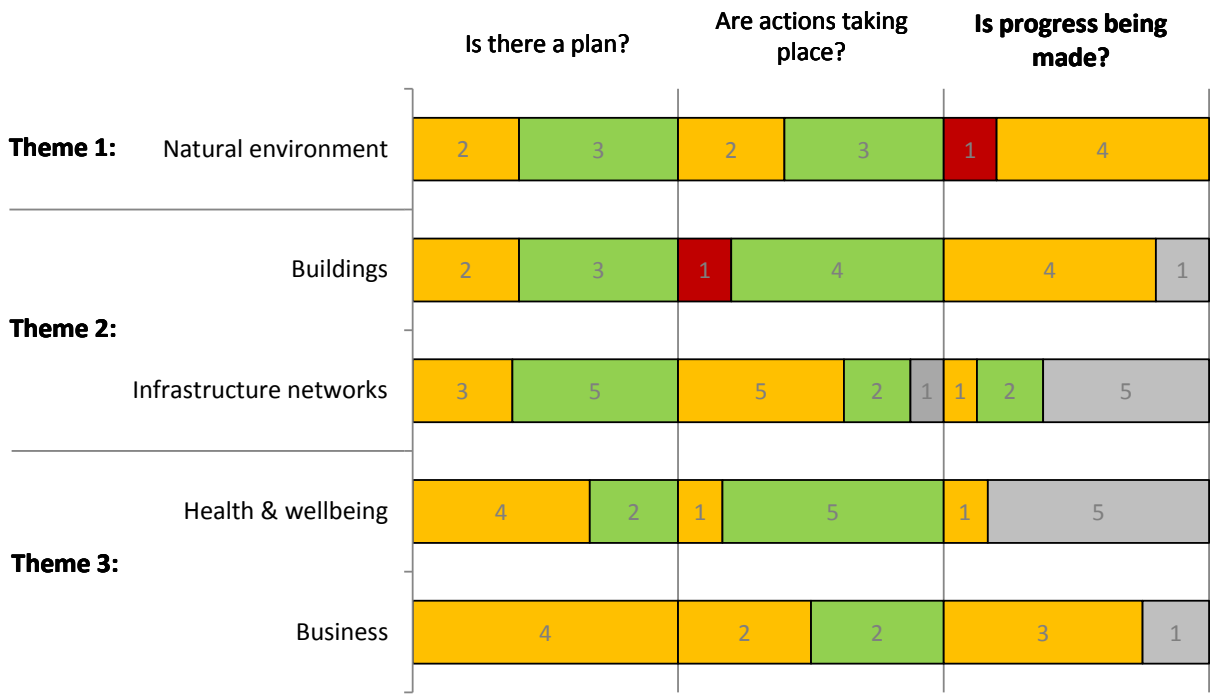
1) **Is there a plan?** The ASC has assessed whether policies and plans in each priority area address the relevant climate risks. For example, national planning policies explicitly consider climate change and provide a basis for planning decisions that account for rising flood risks.

2) **Are actions taking place?** The ASC has sought to identify what steps are being taken to manage climate change risks. As well as assessing whether the policies and proposals listed in the SCCAP are being delivered, the ASC has also reviewed other relevant activity that may be helping to reduce the impacts of climate change.

3) **Is progress being made in managing vulnerability?** The ultimate aim of the SCCAP is to prepare and adapt Scotland for the risks from climate change. To arrive at an overall assessment, the ASC has considered the available evidence to conclude whether vulnerabilities to climate change risks are increasing or decreasing. Recommendations are made where further progress is felt to be most important.

Figure ES.2 presents the overall assessment for the three SCCAP themes (with buildings and infrastructure, and health & wellbeing and business split into separate sub-themes). In many areas, plans and policies are in place and actions are reported as either complete or on track (shown in **green**). Vulnerability is increasing in one specific area (shown as **red** in the third column) and evidence of progress is mixed in others (shown in **amber**). Areas are highlighted in **grey** if there is insufficient evidence to form a judgement.

Figure ES.2: The ASC's interim assessment of the Scottish Climate Change Adaptation Programme



Source: ASC assessment of policies and plans, actions, and progress, in each area identified as an adaptation priority.
Notes: The boxes show the number of adaptation priorities within each theme categorised as either:
- **Red**: plans and policies, delivery of actions, or progress in addressing vulnerabilities, are lacking.
- **Amber**: adaptation priority has been partially addressed, evidence of progress in some areas.
- **Green**: plans are in place, actions are being delivered, progress is being made.
- **Grey**: insufficient evidence to form a judgement.
See Chapter 1 for the full criteria used to inform the ASC's assessment of progress.

The results highlight that in many areas, there are insufficient data to assess whether progress is being made. This is particularly the case for infrastructure, and risks to health and wellbeing.

It is recommended that the Scottish Government work with partners to develop datasets in areas where progress is felt to be most important. Subject to feasibility, the Adaptation Sub-Committee recommends outcome-based indicators are developed in the following areas as a priority:

- Levels of exposure to different sources of flood risk around the country, including projections of future risks taking climate change and current and planned flood risk management measures in to account.
- Impact of new development on long-term flood risks and risk management costs, and the use of sustainable drainage systems to help manage surface water flood risks.
- Performance of infrastructure networks in severe weather.
- Restoration of degraded peatland habitats.

- Rates of soil erosion and uptake of soil conservation measures by farmers.
- Overheating risks in buildings, including monitoring of internal temperatures in hospitals and care homes.
- Current incidence of, and future risks from, pests and pathogens for plants, animals and people, including Lyme disease, invasive mosquito species, and tree diseases.
- Actions being taken by Scottish businesses to prepare for extreme weather and adapt to climate change. Only UK-level data are available at present.
- Water abstraction by businesses and the water intensity of Scottish industry.

Summary of progress: natural environment

Ambitious plans are in place to enhance the resilience of Scotland's natural environment and adaptation is well embedded in key policies and strategies. There is evidence of actions being taken on the ground that will be helping to reduce vulnerability to climate change, including the restoration of degraded peatlands and native woodlands, the designation of Marine Protected Areas and the widespread uptake of agri-environment schemes. The trends in some indicators are moving in a positive direction, for example the proportion of designated sites in a favourable ecological condition is steadily increasing and there have been improvements in the ecological status of Scotland's lochs and estuaries.

However, at the same time, a number of trends continue to be in the wrong direction. For example, key indicator species are in long-term decline, productive soils are being lost to erosion, some unsustainable commercial fishing practices continue, and invasive species, pests and pathogens are extending their range. Further effort is needed to restore degraded habitats particularly peatlands and native woodlands; tackle diffuse pollution and over-abstraction from rivers and lochs; create new coastal habitats to compensate for those at risk from sea-level rise; further reduce damaging fishing practices; protect agricultural soils; and safeguard Scotland's forests from pests and pathogens.

Summary of progress: buildings and infrastructure networks

Widespread flooding in the winter of 2015/16 highlighted the vulnerability of Scotland's communities and essential infrastructure to extreme weather. Many towns and cities in Scotland are located in the floodplain and at risk from river flooding and coastal inundation. In addition, an increase in impermeable surfacing and the restricted capacity of drainage networks increase the risk of surface water and sewer flooding. Infrastructure in Scotland is also exposed to high winds, coastal erosion and cold weather. Transport routes, including for isolated and remote communities, are particularly vulnerable.

Action is being taken to reduce the vulnerability of communities to flood risk and to improve infrastructure performance during periods of extreme weather. However, there are limited data at a national scale to determine the extent to which progress is being made. There is therefore an urgent need for a comprehensive review of whether current actions are sufficient to manage the long-term risk from flooding and extreme weather, the impacts of which can otherwise be expected to increase with climate change.

Summary of progress: Society

Adaptation plans are in place and steps are being taken in Scotland to manage the risks from extreme weather to people and the health and social care system. All NHS Scotland organisations have plans in place to consider climate change risks, and emergency plans cover a range of weather-related risks. Surveillance and early warning systems are in place for air pollution, UV radiation and pathogens. Various actions are being taken to achieve the SCCAP objective to increase public awareness of extreme weather, climate change and its impacts. Whilst the SCCAP did not cover the business sector, support and guidance is available to companies looking to manage climate risks.

However, there is little monitoring and evaluation of how these actions may be affecting vulnerability to climate-related hazards over time. Very little information is collected across the health and business sectors to assess how these and other actions are affecting vulnerability. For some risks, including high and low extremes in temperature, plans have not yet been developed. The future risks to people from UV radiation and vector-borne pathogens have not yet been considered. Businesses are able to access guidance and tools to help them adapt, but the take-up and their impact is not known.

Next steps

The Scottish Government will continue to publish annual progress reports until a new SCCAP, which is expected in 2019, is published.

Now that a new CCRA Evidence Report has been published, the Scottish Government may wish to refresh the priorities and objectives stated in the current SCCAP incorporating the recommendations made in this report. A sensible time to do so would be as part of the Scottish Government's next annual progress report due in May 2017.

The Scottish Government may request a further independent assessment be conducted by the Adaptation Sub-Committee. The Act requires Scottish Ministers to request a further assessment of the progress being made by the SCCAP "as soon as reasonably practicable" after the CCRA is presented to the UK Parliament in January 2017.

In the meantime, the Adaptation Sub-Committee will continue to work with the Scottish Government and others to develop the evidence base in support of future assessments.

Full list of recommendations

Table ES.2 provides the full list of recommendations made in this report, together with their suggested ownership and timing.

Table ES.2: Recommendations from the first assessment of the SCCAP				
Chapter	**Adaptation priority**	**Recommendation**	**Owner**	**Timescale**
The Scottish Climate Change Adaptation Programme (Chapter 1)	n/a	RECOMMENDATION 1: In preparing the next SCCAP the Scottish Government should: • Address all of the urgent risks and opportunities for Scotland identified in the 2017 UK Climate Change Risk Assessment. • Identify a senior owner for each objective that can be held accountable for delivery. • List the specific actions that will be taken to achieve each objective together with appropriate milestones and timescales. • Introduce an effective monitoring and evaluation regime, to allow the impact of actions and delivery of each objective to be fully assessed. • Co-ordinate the actions being taken within each sector especially where they appear within different themes of the SCCAP.	Scottish Government	Next SCCAP in 2019
Natural environment (Chapter 2)	Terrestrial species and habitats	RECOMMENDATION 2: The Scottish Government and Scottish Natural Heritage should by the end of 2017 develop the 2020 Route Map into a clear action plan setting out how the outcomes in the Scottish Biodiversity Strategy will be delivered in the context of climate change.	Scottish Government / Scottish Natural Heritage	End 2017

Table ES.2: Recommendations from the first assessment of the SCCAP				
Chapter	**Adaptation priority**	**Recommendation**	**Owner**	**Timescale**
		RECOMMENDATION 3: Scottish Natural Heritage should commit to developing a monitoring system before the next SCCAP which can measure (a) the impact of climate change on the condition of sites and species and (b) the effectiveness of conservation interventions, thereby enabling the tracking of progress towards favourable ecological condition.	Scottish Natural Heritage	Next SCCAP in 2019
		RECOMMENDATION 4: The Scottish Government and Scottish Natural Heritage should by the end of 2017 establish a target in the Scotland National Peat Action Plan for the area of peatland that will be under restoration by 2030 and introduce and monitor a delivery programme for meeting this target.	Scottish Government / Scottish Natural Heritage	End 2017
	Freshwater rivers and lochs	RECOMMENDATION 5: The Scottish Government and the Scottish Environment Protection Agency should, before the next SCCAP, assess whether the design and operation of the water abstraction regime is compatible with the risk of reduced water availability in coming decades, in a context of projected increases in demand.	Scottish Government / Scottish Environment Protection Agency	Next SCCAP in 2019
	Marine and coastal ecosystems	RECOMMENDATION 6: The Scottish Government should assess by the end of 2017 the implications of increases in marine water temperatures and acidity (both actual and projected) for marine ecosystems, the MPA network, and the commercial fisheries and aquaculture sectors.	Scottish Government	End 2017

Table ES.2: Recommendations from the first assessment of the SCCAP				
Chapter	**Adaptation priority**	**Recommendation**	**Owner**	**Timescale**
		RECOMMENDATION 7: The Scottish Government should, by the end of 2017, set a long-term target for the area of intertidal habitat to be created through managed realignment in Scotland and introduce appropriate policy mechanisms to achieve it.	Scottish Government	End 2017
	Soils and agriculture	RECOMMENDATION 8: The Scottish Government should take action to deliver the vision in its Soils Framework that "soils are safeguarded for existing and future generations". An action plan should be published before the next SCCAP, which includes proposals for: establishing a scheme to monitor the health of agricultural soils and the uptake of soil conservation measures, and taking enforcement action where poor management practices are found.	Scottish Government	Next SCCAP in 2019
	Forestry	RECOMMENDATION 9: Forestry Commission Scotland should consider by the end of 2017 whether additional action is needed to reduce the spread of pests and pathogens, particularly where they threaten native Caledonian pinewoods, and whether further action to increase species diversity in the Public Forest Estate would be beneficial in order to build resilience to climate change.	Forestry Commission Scotland	End 2017

Table ES.2: Recommendations from the first assessment of the SCCAP				
Chapter	**Adaptation priority**	**Recommendation**	**Owner**	**Timescale**
Buildings and infra-structure networks (Chapter 3)	Flooding and coastal erosion risk management	RECOMMENDATION 10: The Scottish Government should assess the level of flood risk management interventions and investments that are likely to be needed to reduce risks in each part of Scotland to acceptable levels over the next 25 to 50 years, accounting for the impacts of climate change and sea level rise. This assessment should help ensure that the objectives set in the next Flood Risk Management Strategies, due in 2021, are compatible with reducing flood risk in the long term.	Scottish Government	In time to inform next FRMSs in 2021.
	Flooding and coastal erosion risk management, Surface water and sewer flooding and Development in flood risk areas	RECOMMENDATION 11: The Scottish Environment Protection Agency should ensure the next Flood Risk Management Strategies monitor and report: 1) The impact of local flood risk management plans in reducing surface water flood risk, including in relation to managing urban creep. 2) The number and capacity of SuDS installed in new developments and of other drainage assets retrofitted with SuDS. 3) The number of planning applications for new developments in the floodplain that were granted, and within these, the number of applications for which SEPA advice was sought and the number of applications to which SEPA objected. 4) The number and location of new homes and other properties built in areas of flood risk.	Scottish Environment Protection Agency	In time to inform next FRMSs in 2021.

Table ES.2: Recommendations from the first assessment of the SCCAP				
Chapter	**Adaptation priority**	**Recommendation**	**Owner**	**Timescale**
	Water demand in the built environment	RECOMMENDATION 12: The Scottish Government should review before the next SCCAP whether further action is required to deliver and sustain reductions in average water consumption per person in Scotland. As part of this review, Scottish Water should publish the outputs of their water efficiency trials, including an assessment of the impact of metering.	Scottish Government /Scottish Water	Next SCCAP in 2019
	Resilience of infrastructure services	RECOMMENDATION 13: The Scottish Government should work with all infrastructure sectors before the next SCCAP to develop consistent incident reporting, together with indicators of network resilience and performance, and the implementation of resilience measures, to allow improvements in resilience to extreme weather events to be measured over time.	Scottish Government	Next SCCAP in 2019
Society (Chapter 4)	Emergency planning and response	RECOMMENDATION 14: The Scottish Government should, before the next SCCAP, assess the current level of capability within the emergency response system to deal with extreme weather events and take further steps as necessary to prepare for climate change.	Scottish Government	Next SCCAP in 2019
	Recovery from extreme weather events	RECOMMENDATION 15: The Scottish Government should, before the next SCCAP, co-ordinate with local authorities to assess the impact on people, businesses and communities arising from flood events, including persistent health and wellbeing effects, and consider what further steps might be taken to help communities recover from extreme weather events more quickly.	Scottish Government	Next SCCAP in 2019

Table ES.2: Recommendations from the first assessment of the SCCAP				
Chapter	**Adaptation priority**	**Recommendation**	**Owner**	**Timescale**
	Resilience of the population to changes in temperature	RECOMMENDATION 16: The Scottish Government should, before the next SCCAP, review policies that address the current and long-term risks from both heat and extreme cold.	Scottish Government	Next SCCAP in 2019
	Resilience of people to pathogens, air pollution, UV radiation	RECOMMENDATION 17: Health Protection Scotland should, before the next SCCAP, carry out new research into the current and future risks to the population from heat and UV radiation, and consider proportionate responses to the risk.	Health Protection Scotland	Next SCCAP in 2019
		RECOMMENDATION 18: Health Protection Scotland should, before the next SCCAP, assess the changing risks to people from vector-borne diseases, making use of the second UK Climate Change Risk Assessment Evidence Report. This should consider priority areas for future monitoring and surveillance and whether current resources are aligned with the areas of greatest current and future risk.	Health Protection Scotland	Next SCCAP in 2019
	Public understandin g of climate related risks	RECOMMENDATION 19: The Scottish Government should, before the next SCCAP, review the take-up and impact of guidance and tools for organisations, businesses and communities provided by Adaptation Scotland.	Scottish Government	Next SCCAP in 2019
	Business impacts from extreme weather	RECOMMENDATION 20: The Scottish Government should, before the next SCCAP, develop policies to encourage businesses in high risk areas to become more flood resilient and report on the actions being taken by businesses as a result.	Scottish Government	Next SCCAP in 2019

Table ES.2: Recommendations from the first assessment of the SCCAP				
Chapter	**Adaptation priority**	**Recommendation**	**Owner**	**Timescale**
	Business opportunities from climate change	RECOMMENDATION 21: The Scottish Government should include actions within the next SCCAP that will help businesses in Scotland understand and exploit the economic opportunities arising from climate change.	Scottish Government	Next SCCAP in 2019
	Water demand by industry	RECOMMENDATION 22: The Scottish Environment Protection Agency should begin, by the end of 2017, to publish annual data on water abstraction by industry (separately from agriculture and energy generation) so vulnerabilities can be assessed and managed over time.	Scottish Environment Protection Agency	End of 2017
		RECOMMENDATION 23: The Scottish Government should, before the next SCCAP, set out how the 'Scotland the Hydro Nation' programme incorporates SEPA's national water scarcity plan.	Scottish Government	Next SCCAP in 2019

Chapter 1: The Scottish Climate Change Adaptation Programme

1.1 The Scottish adaptation policy cycle

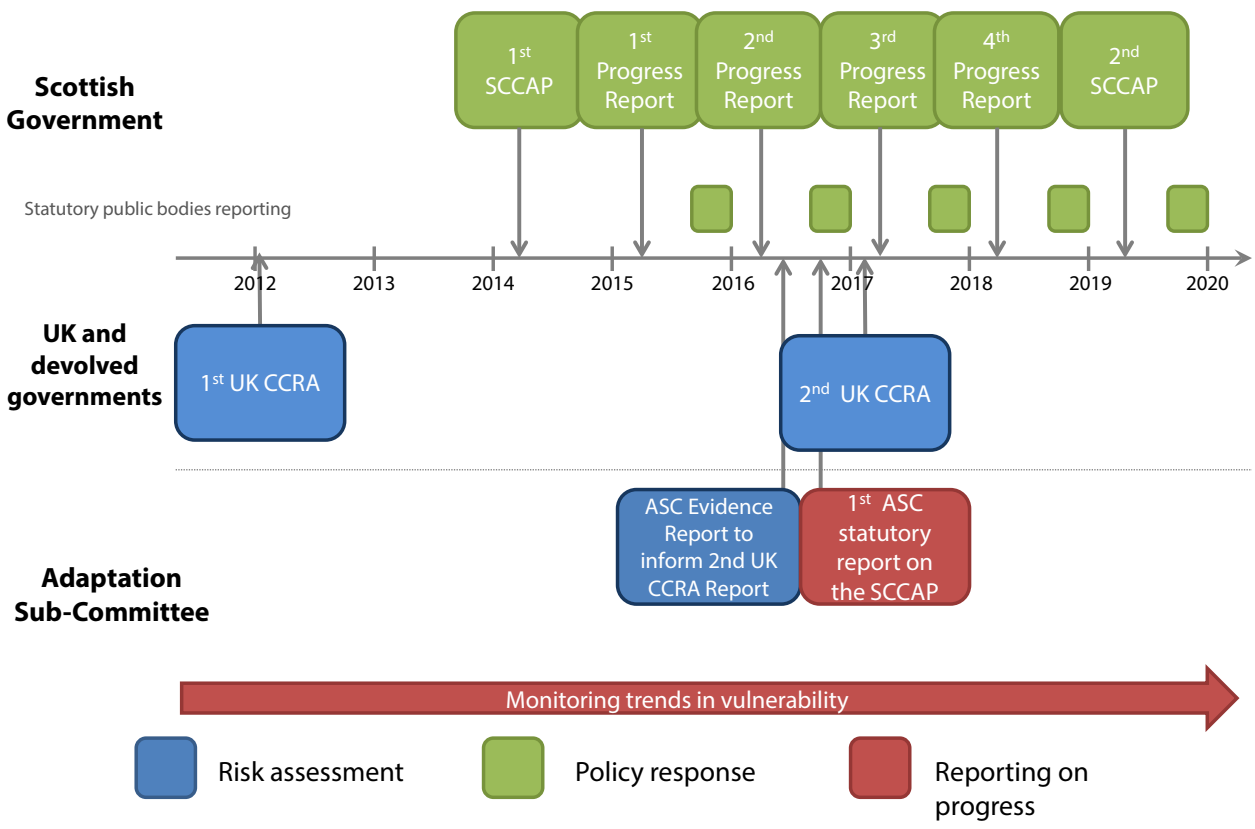
Scotland was one of the first countries to establish a legal framework for adapting to climate change.

The Climate Change Act (Scotland) 2009 created a framework for both mitigating and adapting to climate change. The Act established legally-binding carbon budgets to put Scotland on a trajectory to reduce greenhouse gas emissions by 80% in 2050 compared with 1990 levels.

The Act also put in place requirements to prepare Scotland for climate change and adapt to its impacts (Figure 1.1). Ministers are required to publish and maintain a programme setting out objectives, proposals and policies to address the risks and opportunities facing Scotland from climate change - the Scottish Climate Change Adaptation Programme (SCCAP). Risks and opportunities have been identified by a UK Climate Change Risk Assessment (CCRA), which under UK Climate Change Act 2008 is required to be produced and updated on a five year-cycle. The first UK CCRA was published in January 2012.

The Scottish Government published a non-statutory Adaptation Framework in 2009, accompanied by 12 Adaptation Sector Summaries, followed by updated Sector Action Plans in 2011. The first statutory Scotland Climate Change Adaptation Programme was published in May 2014, with the next programme to be published in 2019.

Figure 1.1: The Scottish adaptation policy cycle



Source: ASC based on the requirements of the Climate Change (Scotland) Act 2009.

Ministers are required to provide Parliament with annual updates on progress. Two such reports have been published to date, in May 2015 and May 2016. The Act also makes provision for an independent assessment of progress towards implementing the objectives, proposals and policies in the statutory adaptation programme. In June 2014 Ministers asked the Committee on Climate Change's Adaptation Sub-Committee (ASC) to undertake this assessment.

Sections 46 and 96 of the Act require public bodies to exercise their functions in ways that contribute towards the delivery of Scotland's emissions reduction targets and the statutory adaptation programme. Following consultation, the Scottish Government laid a statutory order in October 2015 to require public bodies (currently 151 organisations) to publish a report each year on what they are doing on both adaptation and mitigation.

As well as the mandatory requirements within the Climate Change (Scotland) Act 2009, the Scottish Government is also participating in climate change adaptation action at an international level. In December 2015 the Scottish Government pledged an additional £12 million under their Climate Justice Fund to help reduce the impact of climate change on poor communities. Projects are already underway in Malawi and Zambia.

1.2 Climate change risks and opportunities for Scotland

The first UK Climate Change Risk Assessment was published in 2012 (CCRA1) and included a specific section discussing the risks and opportunities for Scotland. Projections of the future climate were based on the UK Climate Projections published in 2009 (UKCP09).[1]

CCRA1 identified 144 climate change risks and opportunities directly relevant to Scotland. A new Evidence Report to inform the second CCRA was published in July 2016, including a specific national summary for Scotland. This assessment however is based on whether the risks and opportunities identified in CCRA1 are being addressed. Where the evidence has changed between CCRA1 and CCRA2, we note the difference and may include recommendations for the next SCCAP as a result. Both CCRA reports highlight that Scotland experiences geographic variations in its climate, as well as differing impacts between urban, rural and remote Scottish regions.

1.3 The first Scottish Climate Change Adaptation Programme

Scotland's first Climate Change Adaptation Programme set nine objectives and describes almost 150 existing policies that will help Scotland prepare for climate change.

The Act requires Ministers to lay a programme before the Scottish Parliament, setting out (a) their objectives in relation to adaptation to climate change; (b) their proposals and policies for meeting those objectives; (c) the period within which those proposals and policies will be introduced; and (d) ensure that the actions under the objectives address the risks identified in the UK Climate Change Risk Assessment. The Act also requires the programme to set out the arrangements for involving employers, trade unions and other stakeholders in meeting Ministers' objectives; and the mechanisms for ensuring public engagement in meeting those objectives.

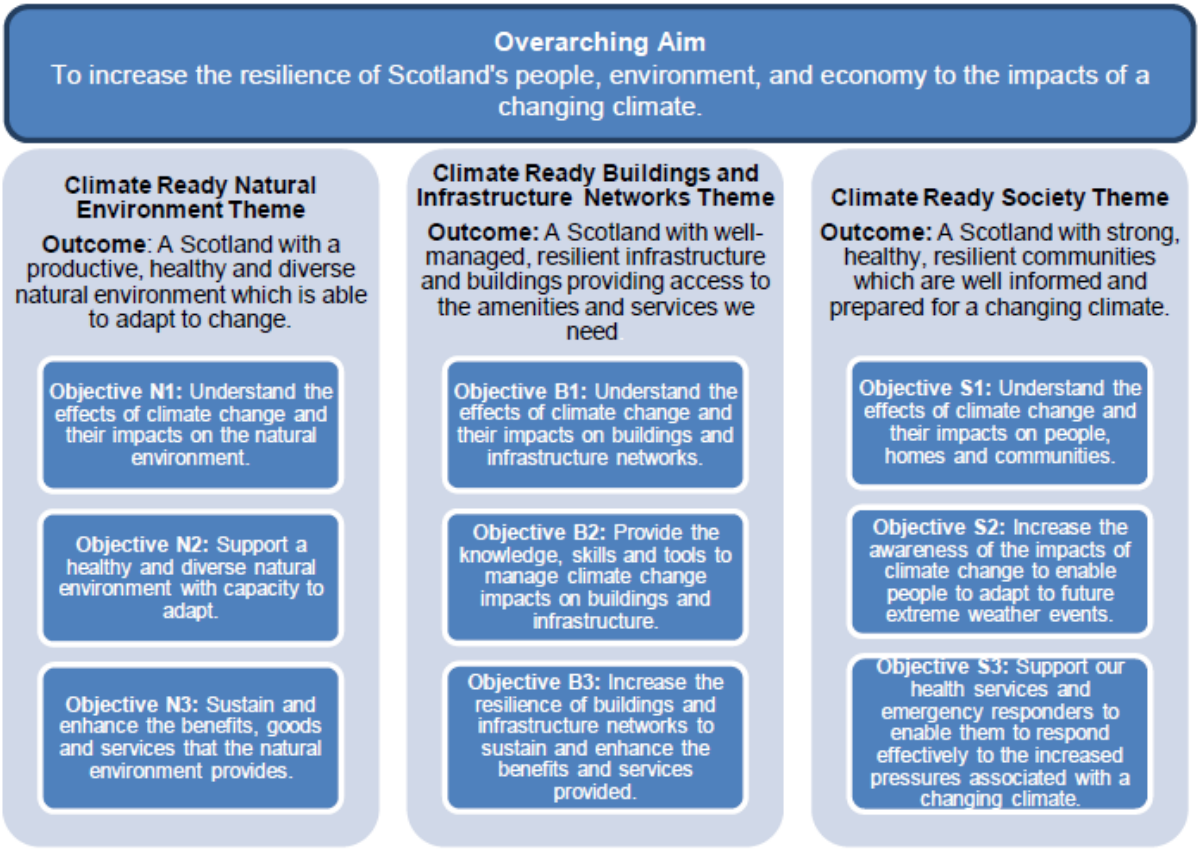
[1] Although seven years old now, UKCP09 continues to provide the best available projections for the Scottish climate. A project is now underway to update the projections for publication in 2018 (UKCP18).

When preparing the SCCAP, the Scottish Government prioritised those risks and opportunities from CCRA1 that were considered to require early adaptation action in Scotland. The SCCAP focuses on devolved areas of policy, with the UK National Adaptation Programme (NAP) dealing with reserved matters.[2] However, where relevant the SCCAP makes reference to policies within the NAP that are important for adaptation in Scotland.

The SCCAP is divided into two parts:

- Part 1 - lays out the Scottish Government's approach to engaging with others, as required under the Act. The SCCAP is a government-led programme where most of the policies and proposals are owned by the Scottish Government and its delivery bodies and agencies. Each of the policies and proposals are delivered by organisations working in collaboration such as universities, utility companies, regulators, voluntary groups and environmental charities.
- Part 2 - sets out policies and proposals under three themes: 'natural environment', 'buildings and infrastructure networks', and 'society'. The policies and proposals are sub-divided into three objectives for each theme. The SCCAP's overarching aim, outcomes for each theme and the nine objectives are detailed in Figure 1.2.

Figure 1.2: Aim, themes and objectives within the Scottish Climate Change Adaptation Programme

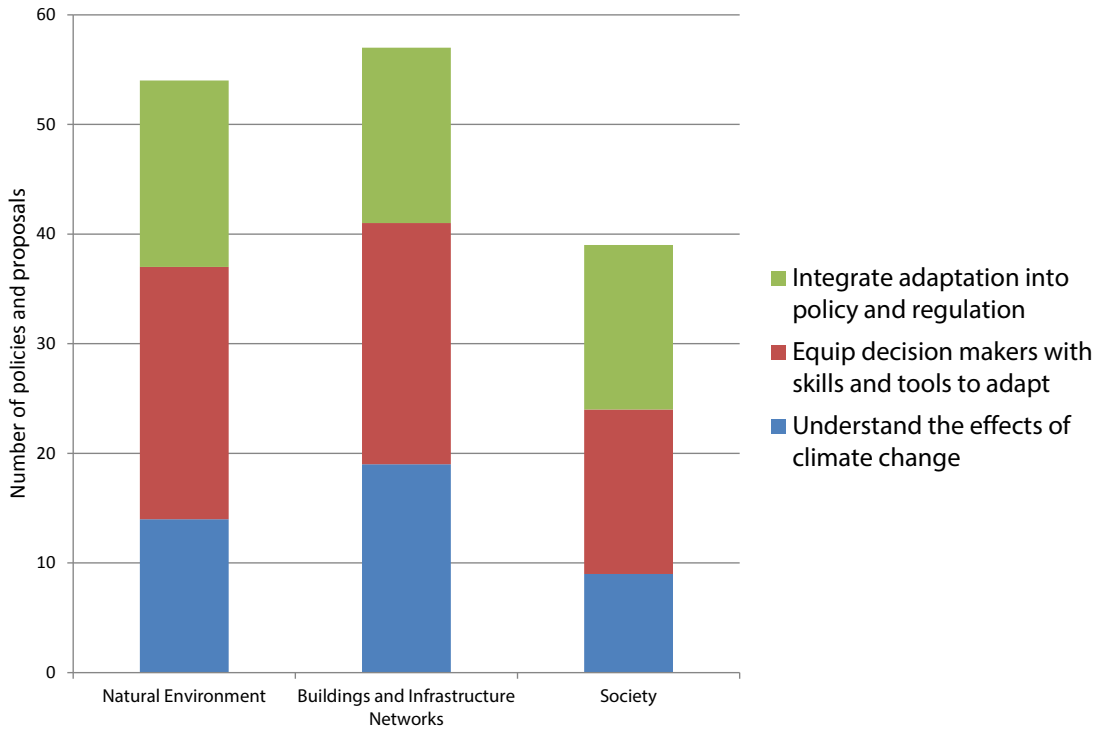


Source: Scottish Government (2014) Climate Ready Scotland: Scottish Climate Change Adaptation Programme.

[2] Reserved matters are those that the UK Government has control over. See: The Scotland Act 1998: Schedule 5. http://www.legislation.gov.uk/ukpga/1998/46/schedule/5

There are a total of 148 policies and proposals in the SCCAP, although only seven of these set an expected completion date. Figure 1.3 provides a breakdown of these policies and proposals by theme and objective.

Figure 1.3: Number of SCCAP policies and proposals by theme and objective

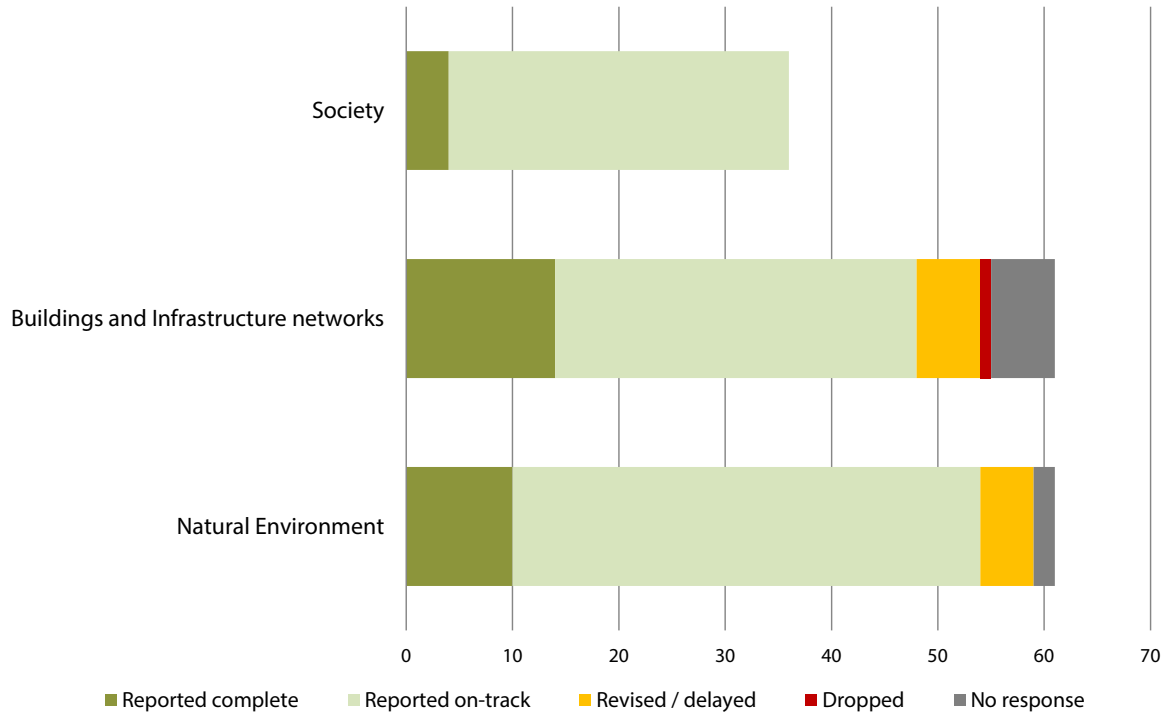


Source: ASC analysis of the actions listed in the SCCAP.

Good progress has been made in delivering the SCCAP policies and proposals, with the majority defined as on track and a good percentage completed.

Since the publication of the SCCAP in 2014, the Scottish Government have prepared two annual progress reports. The updates in the first annual report were purely descriptive, however the 2016 progress report included an assessment of the extent to which the policies and proposals are complete, on track, revised, delayed or dropped. Figure 1.4 shows the results.

Figure 1.4: Progress with delivery of the SCCAP polices and proposals



Source: Scottish Government (2016) Climate Ready Scotland: Scottish Climate Change Adaptation Programme, Second Annual Progress Report.
Notes: The status of each policy or proposal is based on self-reporting by those responsible for their delivery.

1.4 Towards the second Climate Change Adaptation Programme

The next SCCAP is required to be published by the Scottish Government in 2019.

With the formal publication of the second UK Climate Change Risk Assessment in 2017, a renewed SCCAP is due to be published by the Scottish Government in 2019. This should include updated policies and proposals together with revised aims, objectives and outcomes as appropriate.

In the ASC's view the first SCCAP is a positive start and comprehensively summarises current policies and actions underway to prepare the country for climate change. As well as making policy-specific recommendations the ASC recommends some more general findings are addressed when developing the second SCCAP by 2019. These are discussed in the sections that follow.

Some of the risks highlighted for Scotland in the first CCRA are not addressed within the current SCCAP. Around a third of the climate change risks and opportunities identified for Scotland were not included within the first SCCAP. According to the Scottish Government, stated in the SCCAP, this is because:

- risks were deemed too uncertain; or
- of too low a magnitude; or
- considered to be "a prediction rather than a risk".

The unaddressed climate risks include potential losses in priority natural habitats due to coastal erosion, and biodiversity risks due to warmer rivers, lakes and other freshwater bodies. Both of these risks were highlighted in the first CCRA as having potentially high and increasing impacts for Scotland. Whilst risks were flagged as uncertain in the first CCRA, this does not mean they are unlikely to happen and no activity would be worthwhile. In such areas the priority is to reduce the uncertainty in the assessment whilst taking steps that would be beneficial in any event. The 'loss of productivity due to ICT disruption' is one such example, where more research to understand the risk might have been a useful component of the first SCCAP.

There is no clear ownership, oversight and delivery of the objectives stated within the SCCAP. The current SCCAP is overseen by a team in the Scottish Government who work with sector-based colleagues to co-ordinate policies and activity. However, the ownership of each objective is shared between different parts of the Government with no clear ownership and accountability for achieving them.

Sector-specific activity is fragmented across several SCCAP objectives. Whilst grouping SCCAP actions into themes is a logical approach it risks action within individual sectors being fragmented and lacking in co-ordination. For example the water sector has relevant policies and proposals discussed under all three SCCAP themes.

The first SCCAP focuses on evidence-gathering and other supporting measures, rather than taking action to address risks. Over two-thirds of the policies mentioned in the SCCAP relate to strengthening the evidence base, building adaptive capacity, and raising awareness of adaptation issues. Building the evidence base and adaptive capacity are important steps but by themselves are unlikely to lead to vulnerabilities being addressed. For example carrying out workshops and providing guidance are useful steps however they do not guarantee changes will be made on the ground.

Progress against most of the SCCAP objectives, and the impact of policies and proposals, is not being measured. When commenting on the draft SCCAP in December 2013, the Rural Affairs and Climate Change and Environment (RACCE) Parliamentary Committee advised that there should be more outcome-focused targets[3]. Despite this recommendation, 90% of the policies and proposals in the published programme are not directly measurable. As mentioned earlier, of the 148 policies and proposals in the SCCAP only seven of them are time-bound. Some timescales were clarified in the Scottish Government's progress update in May 2016 but this could be improved further in the next programme.

Based on the above conclusions, the ASC recommends that the next SCCAP due in 2019 is improved in the following ways:

RECOMMENDATION 1: In preparing the next SCCAP the Scottish Government should:

- **Address all of the urgent risks and opportunities for Scotland identified in the 2017 UK Climate Change Risk Assessment.**
- **Identify a senior owner for each objective that can be held accountable for delivery.**
- **List the specific actions that will be taken to achieve each objective together with appropriate milestones and timescales.**
- **Introduce an effective monitoring and evaluation regime, to allow the impact of actions and delivery of each objective to be fully assessed.**

[3] Rural Affairs and Climate Change and Environment Parliamentary Committee letter to Minister, December 2013

- **Co-ordinate the actions being taken within each sector especially where they appear within different themes of the SCCAP.**

1.5 Evaluating progress by the Scottish Climate Change Adaptation Programme

The Act requires the ASC to report to Scottish Ministers[4] with its assessment of progress with the implementation of the objectives, policies and proposals in the SCCAP. The ASC has structured this assessment according to a set of specific and measurable 'adaptation priorities'.

Ideally, the ASC would assess the progress being made towards achieving the SCCAP's objectives. However, as already mentioned the objectives are not phrased in ways that allow their achievement to be measured. Even in cases where the stated objectives are being achieved, vulnerability to climate change impacts may be increasing.

To enable a robust assessment, the ASC has divided each of the SCCAP themes into several more specific areas where progress can be measured. We have called these areas 'adaptation priorities'. These are based on the areas where the urgency of adaptation action is greatest and the scale of the challenge means effort will need to be sustained for many decades. For example, to assess the progress being made with managing the risks from climate change to the built environment it is important to understand the progress being made with flooding, water scarcity, and the impacts of extreme wind and rain on buildings. Our analysis of flood risks is further sub-divided in to flood and coastal erosion risk management, surface water and sewer flooding, and controlling development in the flood plain. These form the adaptation priorities for the built environment aspect of the Buildings and Infrastructure Networks theme.

The adaptation priorities used to assess progress with the SCCAP are broadly consistent with the adaptation priorities identified by the ASC for its 2015 assessment of the UK National Adaptation Programme. [5] However, in some cases amendments have been made to reflect the priority climate change risks and differing circumstances in Scotland.

In evaluating progress the ASC has considered three questions in each of the areas identified as a priority for adaptation:

- **Is there a plan?** The ASC has assessed whether policies and plans in each priority area address the relevant climate risks. For example, national planning policies explicitly consider climate change and provide a basis for planning decisions that account for rising flood risks.
- **Are actions taking place?** The ASC has sought to identify what steps are being taken to manage climate change risks. As well as assessing whether the policies and proposals listed in the SCCAP are being delivered, the ASC has also reviewed other relevant activity that may be helping to reduce the impact of climate change.
- **Is progress being made in managing vulnerability?** The ultimate aim of the SCCAP is to prepare and adapt Scotland for the risks from climate change. To arrive at an overall assessment, the ASC has considered the available evidence to conclude whether

[4] The Act requires the "relevant body" to report to Scottish Ministers, and currently the Adaptation Sub-Committee is listed as the relevant body in the associated secondary legislation.

[5] ASC (2015*) Progress in preparing for climate change*. Presented to Parliament pursuant to section 59(1) of the Climate Change Act 2008. https://documents.theccc.org.uk/wp-content/uploads/2015/06/6.736_CCC_ASC_Adaptation-Progress-Report_2015_FINAL_WEB_070715_RFS.pdf

vulnerabilities to climate change risks are increasing or decreasing. Where possible, the evaluation is based on a suite of indicators that has been developed by ClimateXChange (CxC). These indicators[6] where possible measure over time changes in exposure and vulnerability, and observed climate impacts, within each priority area.

As well as considering the activity referenced within the SCCAP, and the annual progress reports, additional information has been gathered through detailed stakeholder discussions, from Adaptation Reporting Power reports[7], public bodies' duties reports, the ClimateXChange indicators, and a wider literature review. In particular we looked for evidence in each area of:

- Whether low-regret adaptation measures are being taken, such as for example property-level flood resilience measures, and whether barriers to uptake are being addressed. If we observe a high uptake of low-regret measures, then it is likely that progress is being made with addressing vulnerabilities.
- We have also reviewed the extent to which decisions being taken today that have long-term consequences are accounting for the future climate, such as for example the extent to which renewals of long-lived infrastructure assets are factoring in projections of the future climate in their location and design. If we find that decisions are taking future climate risks into account, then it is likely that vulnerabilities are being managed.

For each adaptation priority the ASC has given a Red-Amber-Green (RAG) score to summarise the evaluation of progress. A Grey rating is provided where there is currently insufficient evidence to make a judgement. Table 1.1 sets out the criteria for these scores.

Each chapter includes recommendations for where, in the ASC's assessment, there are gaps in the existing policy framework or where current policies could be changed or strengthened in order to increase the pace of progress.

The remainder of this report is structured according to the three themes in the SCCAP.

Each chapter follows a consistent structure, providing:

- an overview of the theme, and the Government's vision and objectives as set out in the SCCAP;
- a description of the primary climate change risks from the CCRA relevant to the theme and the adaptation priorities that have been identified;
- an evaluation of progress against each adaptation priority;
- a commentary on progress with implementing the relevant SCCAP objectives;
- recommendations for where new or revised policies should be considered, or where implementation of existing policy requires strengthening.

[6] http://www.climatexchange.org.uk/adapting-to-climate-change/indicators-and-trends/

[7] Under the Climate Change Act (2008) Defra asked a number of organisations to produce reports on their current and future predicted effects of climate change on their organisation and their proposals for adapting to climate change. Two rounds of reporting have taken place since 2013. https://www.gov.uk/government/collections/climate-change-adaptation-reporting-second-round-reports

Table 1.1: Criteria for the ASC's Red-Amber-Green-Grey assessment of adaptation priorities

Adaptation priority	Is there a plan?	Are actions taking place?	Is progress being made in managing vulnerability?
For example: • Terrestrial species and habitats • Resilience of infrastructure services • Water demand by industry	**Green** – where needed, plans or policies are in place to fully address the adaptation priority in the context of climate change. **Amber** – plans or policies in place that partially address the adaptation priority. **Red** – no specific policies or plans are in place.	**Green** – all relevant SCCAP actions delivered or on track, other relevant plans and policies are being implemented. **Amber** – not all relevant SCCAP actions are on track, with partial delivery of other relevant plans and policies. **Red** – policies are not being implemented and relevant actions are behind schedule. **Grey** – no specific actions in the SCCAP, no apparent activity underway.	**Green** • Vulnerability reducing, or not increasing • High uptake of low-regret actions • Long-term decisions are accounting for climate change projections **Amber** • Some trends in vulnerability increasing • Scope to increase low-regret action • Decisions partially or inconsistently accounting for climate change projections **Red** • Most trends in vulnerability increasing • Minimal uptake of low-regret actions • Decisions do not take climate change projections in to account **Grey** • Insufficient evidence to make a judgement

Chapter 2: Natural environment

Key messages

The impacts of climate change are already being observed across terrestrial, freshwater, coastal and marine ecosystems in Scotland. Many species are shifting their ranges in response to warmer conditions both on land and in the seas. However, the capacity of species and ecosystems to adjust and adapt to climate change is threatened by habitat loss and fragmentation, pollution of land, air and water, damaging land management practices, over-exploitation of marine resources, the spread of invasive species and pathogens, and other pressures.

There are also potential opportunities that could arise from modest climate change, such as longer growing seasons and increased CO_2 fertilisation of some crops. These opportunities will only be realised, however, if limiting factors such as water availability and soil health are managed sustainably.

Ambitious plans are in place to enhance the resilience of Scotland's natural environment and adaptation is well embedded in key policies and strategies. There is evidence of actions being taken on the ground that will be helping to reduce vulnerability to climate change, including the restoration of degraded peatlands and native woodlands, the designation of Marine Protected Areas**,** and the widespread uptake of agri-environment schemes. The trends in some indicators are moving in a positive direction, for example the proportion of designated sites in a favourable ecological condition is steadily increasing and there have been improvements in the ecological status of Scotland's lochs and estuaries.

However, at the same time, a number of trends continue to move in the wrong direction. For example, some key indicator species are in decline, productive soils are being lost to erosion, unsustainable commercial fishing practices continue, and invasive species, pests and pathogens are extending their range. Further action on the ground is needed, including: the wider restoration of peatlands and native woodlands; the reduction of diffuse pollution and over-abstraction from rivers; the creation of coastal habitats to compensate for those at risk from sea-level rise; further reduction of damaging fishing practices; more extensive protection of agricultural soils; and the introduction of further measures to help safeguard forests from pests and pathogens.

Key messages

Overview of progress

Adaptation priority	Is there a plan?	Are actions taking place?	Is progress being made in managing vulnerability?
Terrestrial species and habitats	Green	Amber	Amber
Freshwater rivers and lochs	Green	Amber	Amber
Marine and coastal ecosystems	Amber	Amber	Amber
Soils and agriculture	Amber	Green	Red
Forestry	Green	Green	Amber

Summary of progress

Overall, climate change adaptation is well embedded in key policies and strategies for Scotland's natural environment and a wide range of actions are being taken to build resilience. However, there is scope for further progress to be made in reducing vulnerability in important areas.

- **Ambitious goals have been set to enhance and restore Scotland's biodiversity.** Scotland's Biodiversity Strategy sets a target of 80% of designated sites and species being in a favourable condition by 2016. This target appears to have been met, although there is some uncertainty as to how 'favourable condition' is being defined. Some progress is also being made with restoring degraded habitats, particularly peatlands and native woodlands so they are more resilient to climate change.
- **Adaptation principles have been established to inform biodiversity conservation policy and practice.** These principles aim to help nature adapt to climate change and have been embedded in the Scottish Biodiversity Strategy.
- **Action is being taken to protect and enhance the freshwater environment.** River Basin Management Plans promote a strategic approach to water management and a target is in place for all water bodies to be in good ecological condition by 2027. Currently, 55% of rivers and 67% of lochs meet the target, a slight improvement from 2008. Scottish Water has committed £400 million for environmental improvements between 2015 and 2021.

Key messages

- **Progress is being made in addressing adverse pressures facing the marine environment.** There is a statutory process for marine spatial planning that explicitly accounts for climate change, and reforms to the EU Common Fisheries Policy are starting to reduce unsustainable fisheries practices. To date, 30 Marine Protected Areas have been designated. Almost all (97%) coastal waters and the majority (83%) of estuaries are in good ecological condition, although saltmarsh habitats are being extensively affected by 'coastal squeeze'.
- **A strategic approach is being taken to land use and agri-environment schemes are well established.** The Land Use Strategy has established principles for sustainable land use and there is a policy aspiration that all soils are to be safeguarded for future generations. Over one-third of agricultural land is covered by the Agri-Environment Climate Scheme, which will be encouraging some uptake of soil protection measures although there is scope for further effort to reduce soil erosion and compaction.
- **Decisions on the long-term management of the public forest estate are generally taking account of climate change.** Long-term decisions on tree species mix and planting explicitly account for climate change. With regard to the near-term, actions are being taken to reduce adverse pressures, particularly from deer, invasive species, and pathogens. There is also clear guidance for forest managers on steps they should take to reduce the risk of wildfire and to minimise damage from high winds.

Despite these positive actions, there are a number of trends that suggest the vulnerability of the natural environment is not reducing.

- **Although improvements have been achieved in the condition of designated features, long-term indicators suggest that some species and habitats continue to be a cause for concern.** Farmland and upland bird populations have both declined in recent years and are not yet showing signs of recovery. Specialist butterfly species are also not recovering to previous levels. A range of adverse pressures are likely to be holding back the wider recovery of biodiversity, and these pressures are not being fully addressed.
- **It is not clear what steps are being taken for species that are highly vulnerable to climate change.** The adaptation principles for conservation recognise the need for an 'adaptive approach', but do not explicitly set out what measures can, or should, be taken for species and habitats that are at the edge of their geographical range and so highly vulnerable to losing climate space. It is not clear that the impacts of climate change on the condition of designated sites and species are being effectively accounted for in site condition monitoring.
- **Further effort is needed to restore degraded peatlands and to monitor implementation.** Over three-quarters (78%) of the 1.7 million hectares of deep peat soils in Scotland are heavily modified, primarily due to drainage and afforestation. One-third of deep peats are showing signs of erosion and an estimated 16% are completely bare of any peat-forming vegetation. The area under restoration is not being directly monitored and the Government's Peatland Action strategy does not set clear or specific targets against which progress can be measured. It is therefore difficult to assess whether restoration plans are having the desired impact.

Key messages

- **Many rivers and lochs are still not in a good ecological condition.** 38% of surface water bodies and 22% of groundwater bodies continue to suffer from persistent adverse pressures such as diffuse pollution, physical modification, over-abstraction and invasive species. Climate change is likely to exacerbate many of these pressures, particularly during periods of low (and high) flows.
- **The marine environment continues to face deep-seated pressures.** The Scottish Government's target that 70% of commercial fish stocks have quotas set in line with scientific guidance has not been met, although the proportion has increased on 2014 levels. A number of seabird populations are in long-term decline and invasive species are increasing their range. Changes at the base of the marine food chain due to higher sea temperatures and ocean acidification have potentially far-reaching implications and warrant more research and early policy consideration. There is currently no national long-term vision or plan proposing the area of intertidal habitat to be created through managed realignment in Scotland.
- **The resilience of some current farming systems to changing climatic conditions is in doubt.** Soil organic carbon levels are declining in arable soils and erosion rates are significantly higher in those parts of Scotland where the majority of arable farming is located. It is not clear whether or how the policy aspiration for all soils to be safeguarded is being met. There is also evidence that some pests and diseases that are sensitive to climatic conditions, such as liver fluke, are becoming more widespread. These trends suggest that the potential benefits to Scottish agriculture from longer growing seasons may be jeopardised.
- **Scotland's forestry sector is facing increasing challenges from pests and diseases.** There are concerning trends in the incidence of Dothistroma needle blight (DNB), which could have potentially devastating effects on both commercial forestry and on native Caledonian pine woodlands. Current measures do not appear to be managing the spread of DNB, and the risk - along with that from other pests, pathogens and invasive non-native species - can be expected to increase in the future with climate change. The relatively low level of tree species diversity in Scotland arguably further increases the risk from new and emerging pests, diseases and invasive species that could flourish with warmer temperatures.

Recommendations for further progress

A number of policies and programmes need to be better implemented, and in some cases strengthened, to deliver a more resilient natural environment in Scotland.

RECOMMENDATION 2: The Scottish Government and Scottish Natural Heritage should by the end of 2017 develop the 2020 Route Map into a clear action plan setting out how the outcomes in the Scottish Biodiversity Strategy will be delivered in the context of climate change.

RECOMMENDATION 3: Scottish Natural Heritage should commit to developing a monitoring system before the next SCCAP which can measure (a) the impact of climate change on the condition of sites and species and (b) the effectiveness of conservation interventions, thereby enabling the tracking of progress towards favourable ecological condition.

Key messages

RECOMMENDATION 4: The Scottish Government and Scottish Natural Heritage should by the end of 2017 establish a target in the Scotland National Peat Action Plan for the area of peatland that will be under restoration by 2030 and introduce and monitor a delivery programme for meeting this target.

RECOMMENDATION 5: The Scottish Government and the Scottish Environment Protection Agency should, before the next SCCAP, assess whether the design and operation of the water abstraction regime is compatible with the risk of reduced water availability in coming decades, in a context of projected increases in demand.

RECOMMENDATION 6: The Scottish Government should assess by the end of 2017 the implications of increases in marine water temperatures and acidity (both actual and projected) for marine ecosystems, the MPA network, and the commercial fisheries and aquaculture sectors.

RECOMMENDATION 7: The Scottish Government should, by the end of 2017, set a long-term target for the area of intertidal habitat to be created through managed realignment in Scotland and introduce appropriate policy mechanisms to achieve it.

RECOMMENDATION 8: The Scottish Government should take action to deliver the vision in its Soils Framework that "soils are safeguarded for existing and future generations". An action plan should be published before the next SCCAP, which includes proposals for: establishing a scheme to monitor the health of agricultural soils and the uptake of soil conservation measures, and taking enforcement action where poor management practices are found.

RECOMMENDATION 9: Forestry Commission Scotland should consider by the end of 2017 whether additional action is needed to reduce the spread of pests and pathogens, particularly where they threaten native Caledonian pinewoods, and whether further action to increase species diversity in the Public Forest Estate would be beneficial in order to build resilience to climate change.

2.1 Risks to, and opportunities for, Scotland's natural environment from climate change

Scotland's rich wildlife and distinctive landscapes are a source of inspiration to millions of people.

The mountains, moorlands and heath, which cover 46% of Scotland's land area, contain 90% of the UK's montane habitat and one of the largest contiguous areas of blanket bog in the world, as well as iconic species such as mountain hare, golden eagle and red deer, ptarmigan, dotterel and wildcat.[8] Scotland is home to habitats unique to the UK, such as coastal machair and Caledonian pinewoods. Freshwater habitats support globally important populations of Atlantic salmon and freshwater pearl mussels. Almost 1,000 species of bryophytes (mosses) occur in Scotland, representing 87% and 60% of UK and European totals respectively.[9] Scotland is internationally important for breeding seabirds, hosting around a third of the EU's population including the

[8] RSPB (2015) *Pressures affecting conservation status of designated natural features in Scotland: Impacts, policy context and recommendations.*

[9] Ibid

majority of the global populations of Manx shearwaters and great skuas. Scotland's seas are also of international importance for whales and dolphins and are home to 90% of the UK's grey seal population.

A suite of 1,868 protected areas on land and sea have been designated under national, European and international legislation. Together, these cover 18% of Scotland's land area and 20% of Scotland's seas. Sites of Special Scientific Interest (SSSIs) are the primary type of wildlife designation, with 1,425 individual sites in Scotland. Designated sites make a significant contribution to the protection of 39 biodiversity priority habitats and 197 priority species in Scotland. Protected sites of European importance are also designated as Special Protection Areas (SPAs) and Special Areas for Conservation (SACs) under the EU Birds and Habitats Directives respectively. Of these, 51 sites are also designated as internationally important wetlands under the Ramsar Convention. In 2014, 30 Marine Protected Areas were designated in Scotland's territorial and off-shore waters.

The value of Scotland's natural capital is increasingly being recognised.

Many people place an intrinsic value on nature and consider that society has a duty to protect natural assets for current and future generations. There is a growing recognition that 'natural capital' is as vital to current and future prosperity as social and economic capital. Natural capital can be defined as the stocks of natural assets which include geology, soil, air, water and all living things.[10] Humans derive a wide range of services from natural capital, often called ecosystem services, which make human life possible. A Scottish Forum for Natural Capital was established in 2013, which states that:

"The value of Scotland's natural capital to sectors like tourism, food and drink, and to society as a whole is huge. The most obvious ecosystem services include the food we eat, the water we drink and the plant materials we use for fuel, building materials and medicines. There are also many less visible ecosystem services such as the climate regulation and natural flood defences provided by forests, the billions of tonnes of carbon stored by peatlands, or the pollination of crops by insects. Even less visible are cultural ecosystem services such as the inspiration we take from wildlife and the natural environment".[11]

It has been estimated that around one-fifth of Scotland's industries rely on the natural environment.[12] The main contribution of natural capital to the market economy in Scotland comes from outdoor recreation, tourism, and food and fibre production, totalling around £23 billion per year (approximately 19% of GDP).[13]

- Visits to the outdoors made by people living in Scotland generated around £2.3 billion in expenditure in 2010 and the Cairngorms National Park receives over 1.4 million visitors each year. Nature-based tourism is estimated to be worth £1.4 billion per year and supports 39,000 jobs.[14]

[10] World Forum on Natural Capital, http://naturalcapitalforum.com/about/

[11] http://naturalcapitalscotland.com/

[12] Scottish Natural Heritage (2008) *Valuing our Environment: The economic impact of Scotland's Natural Environment,* http://www.snh.gov.uk/docs/B313698.pdf

[13] Williams E (2009) *Preliminary exploration of the use of ecosystem services values in a regulatory context.* Environmental and Resource Economics Project Report for the Scottish Environment Protection Agency (SEPA).

[14] Scottish Natural Heritage (2010) *Assessing the economic impacts of nature base tourism in Scotland*, http://www.snh.gov.uk/docs/B726802.pdf

- Scotland's marine environment provides for a significant fishing and aquaculture industry, representing £1.4bn in annual turnover and 8,000 jobs. Although marine fisheries contribute less than 1% to the GDP of Scotland, in some regions fishing is the mainstay of employment and about 60% of the UK's commercial marine fish are landed in Scotland. The production of farmed Atlantic Salmon had an estimated value of £677 million in 2013, and the shellfish industry is estimated to be worth £17 million. The value of marine biodiversity-related industries in Scotland was estimated to be over £1.2 billion in 2004.
- The 1.4 million hectares of forest in Scotland support a significant forestry industry that contributed £954 million Gross Valued Added (GVA) to the Scottish economy in 2015. This has increased from £670 million GVA in 2008.[15] Of this £954 million, £771 million was from forestry and timber processing and £183 million from forest recreation and tourism. Employment levels have also increased with over 25,000 FTE jobs now provided by the sector, of which 19,500 are in forestry and timber processing and 6,000 in forest recreation and tourism. Private sector investment in the industry has continued at about £60 million each year. Annual timber production has increased to record highs, reaching 8.6 million cubic metres in 2013.[16]
- Agriculture is also a significant contributor to Scottish GDP, including from specialist exports. Scotland's food and drink sector has an annual turnover of around £14 billion and increased in value by over 20% between 2008 and 2012, making it one of the fastest growing sectors in the economy. Agriculture, forestry and fishing support 1 in 6 jobs in remote rural areas, annually purchasing £1 billion in goods and services from other parts of the Scottish economy and underpinning key growth industries such as food and drink, energy and tourism.[17]

Clean water and natural carbon storage in plants and soils are also of significant importance. Scotland's water resources comprise 90% of the total volume of surface freshwater in the UK, with some 35 billion cubic metres of water stored in the 27,000 lochs in Scotland and 42 billion cubic metres in Scotland's soils.[18] Scotland's peatlands cover about 20% of the total land area (1.7 million hectares) and contain an estimated 1.6 billion tonnes of carbon, ten times more than is stored in all UK trees. The 'non-market' values of clean water and natural carbon stores are increasingly being recognised by policy-makers.

The first CCRA, published in 2012, identified a number of the risks to the natural environment in Scotland, including:

- **Changes in climate space** – Species are said to track their 'climate space', the geographical region which has the appropriate climatic conditions for a species to survive. Species are projected to move northwards and to higher altitudes through the century in response to changes in climate space. Species on the edge of their climatic range may become extinct locally.
- **Seasonal shifts and changes in phenology** – Species will adapt to changes in climate at differing rates. Across an ecosystem, changes in the abundance or distribution (through time

[15] http://scotland.forestry.gov.uk/supporting/forest-industries/economic-contribution-report
[16] Forestry Commission Scotland (2015) *Scottish Forestry Strategy: Progress Report (2014-15),* http://scotland.forestry.gov.uk/images/corporate/pdf/sfs-implementation-plan-2015-2016.pdf
[17] Scottish Government (2015) *The future of Scottish agriculture: a discussion document*, http://www.gov.scot/Publications/2015/06/6695
[18] For comparison, 1 cubic metre equates to the average daily water use of 6 people in a household.

or space) of one species can have significant impacts on other species, particularly those in the same food chain. There is already evidence of changing migration patterns for some bird species in Scotland such as kittiwakes.

- **Pests and diseases and non-native species** – Changes in climate provide opportunities for pests and diseases and human introduced non-native invasive species to become established. In Scotland, milder winters could increase survival rates of pests and diseases.
- **Soil moisture and organic carbon content** – Reduction in summer rainfall is likely to have an impact on groundwater levels, and together with increased evapotranspiration in warmer weather, may reduce soil moisture levels. Whilst having obvious implications for water-rich habitats (such as blanket bog) this can also adversely affect biodiversity and productivity in agriculture and forestry. By the 2080s, projections suggest a 10-23% yield loss from forestry due to drought in northern Scotland.[19]
- **Changing water quality and temperature (including impacts on the marine fishing industry)** – An increase in the frequency and intensity of heavy rainfall events (particularly following periods of drought) could decrease water quality in rivers and lochs. Increasing water temperatures also have implications for water quality, as well as increasing the potential for water-borne diseases.
- **Coastal erosion** – Scotland's coastline is under threat from sea level rise. However, as 70% of the coastline is classified as hard rock, erosion rates will be lower than for some other parts of the UK. The primary impact will be on Scotland's Firths where the bedrock is softer and more susceptible to erosion. Habitats such as saltmarshes are particularly vulnerable.
- **Flooding** – can also cause issues such as waterlogging of dryland habitats (i.e. grasslands) as well as decreasing agricultural yield. Wetter winters are likely as is flooding from more extreme rainfall. The amount of land regularly flooded could double.[20] Rising sea levels will also lead to the loss of coastal habitats and the natural flood protection provided by, for example, saltmarshes.
- **Drought and wildfire** – Warmer average summers and the potential for increases in the frequency of droughts would have impacts on many terrestrial habitats found in Scotland, especially vulnerable peatlands. Drier weather can also increase the likelihood of wildfires that can have significant impacts on the forestry industry.

In July 2016, the ASC published an Evidence Report to inform the second CCRA. The Evidence Report includes a national summary for Scotland, which covered the above risks from CCRA1 but also highlighted additional risks, including:

- reduced water availability in some catchments; and
- changes in marine ecosystems due to warmer sea temperatures and ocean acidification.

The ASC's Evidence report also highlighted potential opportunities from changes in agricultural and forestry productivity and land suitability.

[19] HMG (2012) *UK Climate Change Risk Assessment. Forestry sector report*.
[20] HMG (2012) *UK Climate Change Risk Assessment. Flooding sector report*.

2.2 SCCAP objectives for the natural environment

The SCCAP contains a high level outcome: "A Scotland with a productive, healthy and diverse natural environment which is able to adapt to change" There are three objectives for the Natural Environment theme:

Objective N1: Understand the effects of climate change and their impacts on the natural environment.

Objective N2: Support a healthy and diverse natural environment with capacity to adapt.

Objective N3: Sustain and enhance the benefits, goods and services that the natural environment provides.

The SCCAP objectives describe important high-level principles and goals for adaptation in the natural environment. However, as noted in Chapter 1, the objectives tend to describe processes rather than outcomes and do not reference benchmarks or targets against which substantive progress can be measured. Even where the SCCAP objectives are being achieved, vulnerability to climate change impacts may be increasing.

To enable a more robust assessment, the ASC has identified a set of adaptation priorities for each of the SCCAP themes. The progress being made in respect of each of these adaptation priorities is reviewed in Section 2.3. Progress with each of the three SCCAP objectives is also summarised in Section 2.4.

Figure 2.1 presents the climate hazards, contextual factors and adaptation priorities that are relevant to the natural environment theme, together with a summary of the relevant actions listed in the SCCAP.

Figure 2.1: Climate hazards, contextual factors and adaptation priorities for the natural environment

Climate hazards	Contextual factors	Adaptation priorities	Summary of relevant SCCAP policies and proposals
Warmer, drier summers Reduced water availability Changes to ocean water temperatures and quality Increased winter rainfall More heavy rainfall days Sea level changes	Population growth Economic growth Land-use change Leaving the European Union	Terrestrial species and habitats	• Implement the Scottish Biodiversity Strategy and Land Use Strategy • Develop a UK terrestrial Biodiversity Climate Change impacts report card • Demonstrate adaptive management in national nature reserves • Support volunteer monitoring environmental change • Prepare best practice guidance on wild deer management • Support the Scottish Wildfire forum
		Freshwater rivers and lochs	• Implement River Basin Management Plans • Support the development of local flood risk management plans
		Marine and coastal ecosystems	• Develop regional marine plans following the National Marine Plan and manage the 30 marine protected areas • Support marine research programmes including MarClim and MCCIP • Support the development of Flood Risk Management Strategies and Plans • Scottish planning policy consideration of coastal habitats • Support National Coastal Change Assessment
		Soils and agriculture	• Deliver research on Scottish food security • Promote 'Farming for a Better Climate', 'Future proofing Scotland's farming' and 'sourcing for growth initiative' to consider sustainable supply chains • Implement CAP • Support programmes to prevent spread of pests and diseases
		Forestry	• Develop spatial modelling of different climate scenarios • Demonstrate adaptation strategies for all types of woodland. • Collaborative research into tree pests and diseases • Forest Grant scheme to support creation of new woodland • Promote the UK Forestry Standard, Climate Change guidelines and use of the Ecological Site Classification.

2.3 Progress being made

This section evaluates the extent to which the actions and policies in the SCCAP and elsewhere are addressing the identified climate risks, following the method outlined in Chapter 1. Further details and the underlying evidence supporting the analysis of each of the adaptation priorities can be found in Annex A, available on the CCC's website.

2.3.1 Terrestrial species and habitats

Is there a plan?	 Green	The Scottish Biodiversity strategy aims to ensure that: • 15% of degraded ecosystems are under restoration by 2020. • At least 80% of designated features are in favourable condition by 2016. Scotland's National Performance Framework includes the following indicators: • Improve the condition of protected nature sites. • Increase the abundance of terrestrial breeding birds. • Increase natural capital. A National Peatland Plan was published in 2015.
Are actions taking place?	 Amber	• An average of 1,400 ha per year of peatland has benefited from restoration between 1990 and 2012, though this is well below the 21,000 ha per year that has been assessed as technically achievable. • The number of peat restoration projects increased from 47 (between 1990 and 2012) to 105 in 2015. • The area of native woodland restoration has increased from 400 ha in 2005/06 to over 5,000 ha in 2012/13. • 30-40 'landscape-scale' conservation projects are ongoing covering ~390,000 ha.
Is progress being made in managing vulnerability?	 Amber	• 80% of designated sites were classed as being in a favourable condition in 2016, although this includes sites that are 'recovering' and expected to meet favourable condition in time. • 10% increase in the proportion of blanket bog and native pinewoods in favourable condition, although this is primarily due to sites being classed as 'recovering'. • Farmland birds have declined since 2007 and 61% of butterfly indicator species are in long-term decline.

Is there a plan?

Policies are in place with ambitious targets that, if met, would do much to improve the resilience of Scotland's terrestrial species and habitats to climate change.

The 2020 Challenge for Scotland's Biodiversity (2013)[21] is the Scottish Government's strategy for biodiversity in response to the Aichi Targets set in 2010 by the UN Convention of Biological Diversity (CBD). A Route Map to 2020 was published in 2015 that lists 12 Priority Projects based around six 'Big Steps' for nature.[22] These include commitments to reverse historical losses of habitats and ecosystems, to restore degraded ecosystems and to secure the future of priority habitats and species.

Building the resilience of Scotland's natural environment to the impacts of climate change will require significant restoration of sensitive habitats that have been degraded over time by a range of damaging practices and pressures. In relation to terrestrial ecosystems, the Route Map places emphasis on the need to restore two key types of habitat: peatlands and native woodlands.

- **Peatlands:** Over three-quarters (78%) of deep peat soils in Scotland are heavily modified, primarily from historical drainage and afforestation. Heavily modified peatlands are more prone to being degraded and as a result less resilient to current and future climate impacts. It is estimated that over one-third of peatlands are actively eroding[23] and 16% are bare of any peat-forming vegetation.[24] A National Peatland Plan was published in 2015 with the aim of co-ordinating a programme of restoration.[25] The Plan does not set a specific measurable restoration target, but refers to the Scottish Government's 2013 Low Carbon Plan[26] which states that restoration of 21,000 ha per annum up to 2027 is "technically achievable".
- **Native Woodlands:** In 2014, 17% of the total cover of native woodland was naturally regenerating, which is likely to be too low an area to sustain these fragile habitats in the long-term.[27] The Route Map includes an aspiration to restore approximately 10,000 ha of native woodland into "satisfactory" condition by 2020, in partnership with private woodland owners. There is also a target to create 3,000 to 5,000 ha of new native woodland per year.

The Route Map states that the above habitat restoration goals will deliver the Aichi target of 15% of degraded ecosystems being under restoration by 2020. However, no estimate is made of the area of restoration required to meet the 15% target and therefore whether the above commitments are likely to be sufficient.

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21 Scottish Government (2013) *2020 Challenge for Scotland's Biodiversity - A Strategy for the conservation and enhancement of biodiversity in Scotland,* http://www.gov.scot/Publications/2013/06/5538

22 Scottish Government (2015) *Scotland's Biodiversity - a route map to 2020*, http://www.gov.scot/Publications/2015/06/8630

23 Cummins R, Donnelly D, Nolan A, Towers W, Chapman S, Grieve I & Birnie RV (2011). Peat erosion and the management of peatland habitats. *Scottish Natural Heritage Commissioned Report* No. 410.

24 ClimateXChange (2015) NB13: Area of modified deep peat soils.1,329,000 ha of deep peat soils are modified, out of a total of 1,700,000 ha. Of this, 732,000 ha are drained, 235,000 ha afforested and 268,000 ha are bare.

25 Scottish Natural Heritage (2015) *Scotland's National Peatland Plan: Working for our future*, http://www.snh.gov.uk/docs/A1697542.pdf

26 Scottish Government (2013) *Low Carbon Scotland - Meeting our Emissions Reduction Targets 2013-2027,* http://www.gov.scot/Topics/Environment/climatechange/scotlands-action/lowcarbon/meetingthetargets

27 ClimateXChange (2015) NB23: Amount of natural regeneration in native woodlands. It is estimated that 15-35% is the minimum average cover of established regeneration required to sustain Scottish native woodlands.

Protected sites and features in a favourable ecological condition will be more resilient to climate change than degraded sites. The Route Map sets a target that 80% of 'designated features' will be in a favourable condition by 2016.[28] The Scottish Government also reports annually on 55 national indicators to show progress towards a range of national outcomes, one of which is to improve the condition of protected nature sites. [29] There are also indicators tracking the abundance of terrestrial breeding birds and the status of Scotland's natural capital.

Scottish Natural Heritage (SNH) has developed a set of adaptation principles to help nature adapt to climate change.[30] The principles are reflected in the 2020 Challenge and include improving site condition, reducing existing pressures and increasing connectivity. The adaptation principles also recognise the need for an adaptive approach to land and conservation management, including consideration of more flexible conservation objectives and management measures to reflect changing climatic conditions, as well as the possible role of species translocation.

There is also active research into biodiversity resilience in Scotland. For example, research on woodland resilience by Forest Research, James Hutton Institute, and the Centre for Ecology and Hydrology is being used to inform policy and practice through the Scottish Tree Health Advisory Group, and in SNH and Forestry Commission Scotland guidance.

Invasive species, pests and pathogens are a considerable threat to Scottish biodiversity, with 19% of all designated features affected. The 2020 Challenge states that prevention, monitoring and taking action once threats are detected will be key.

Are actions taking place?

There is evidence of some action being taken to implement the Scottish Biodiversity Strategy, but the delivery of peatland and native woodland restoration is significantly below the technical potential.

A number of specific actions in the SCCAP are being implemented that will contribute to building the resilience of terrestrial species and habitats. SNH are demonstrating the practical application of its 'adaptation principles' within the National Nature Reserves (NNRs) that they own and manage, and in partnership with other protected areas and nature reserves. Climate change has also been integrated into SNH's wildlife management framework.

A major incentive for action to improve the condition of protected sites and restore degraded habitats is the Scottish Rural Development Programme, which is funded under Pillar 2 of the EU Common Agricultural Policy. The SRDP has a total budget of £355 million for the period between 2014 and 2020 and includes a specific Agri-Environment Climate Scheme with a strand of funding for climate change adaptation.

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[28] Each designated site in Scotland contains one or more natural features of special interest describing the plants, animals or habitats, their rocks or landforms, or a combination of these. There are ~5,350 designated features in total across Scotland. Natural feature condition in Scotland is determined by SNH's Site Condition Monitoring (SCM) programme.

[29] Scotland Performs measures and reports on the progress of the Scottish Government against 55 indicators set out in the National Performance Framework (NPF). The indicators provide a broad measure of national and societal wellbeing, incorporating a range of economic, social and environmental indicators and targets which are updated as soon as the data are available. http://www.gov.scot/About/Performance/scotPerforms

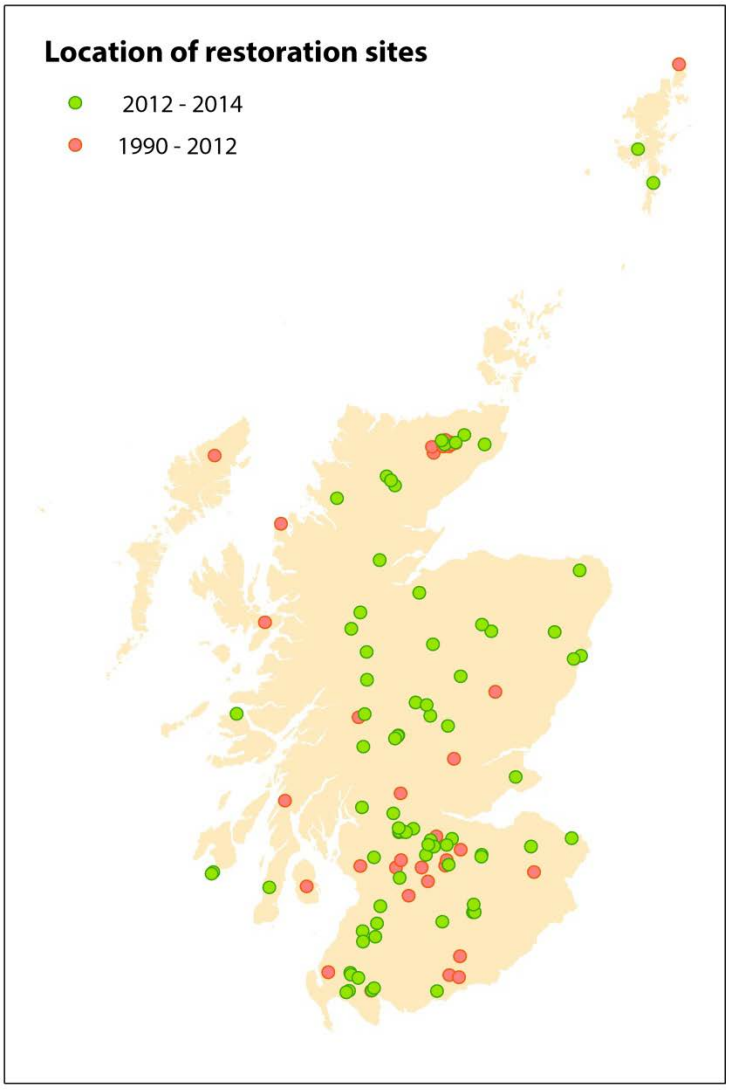
[30] http://www.snh.gov.uk/climate-change/taking-action/adapting-to-change/helping-nature-adapt/turning-principles-into-practice/

A programme of peatland restoration, Peatland Action, started in 2012 with initial capital investment of £5 million from the Green Stimulus Package and a further £3 million announced in 2015.[31] It is not clear whether additional capital funding in future years will be forthcoming. However, £10 million has been allocated for peatland restoration between 2015 and 2021 as part of the Scottish Rural Development Programme, funded under the EU Common Agricultural Policy. Restoration is also incentivised through various programmes including the Heritage Lottery Fund and EU-LIFE programme.

It has been estimated that an average of 1,400 ha of degraded peatland was restored per year between 1990 and 2012. The area under restoration is thought to have increased since 2012, to between 3,000 and 6,000 ha per year (Figure 2.2). However, this estimate is not based on any quantifiable mapping or survey, but reflects the increase in the number of sites under restoration (47 between 1990 and 2012 to 105 in 2015). Even the upper end of this estimate is well below the 21,000 ha per year that is technically achievable, according to the Scottish Government's 2013 Low Carbon Plan.

[31] http://www.snh.gov.uk/climate-change/taking-action/carbon-management/peatland-action/information-for-applicants/

Figure 2.2: Location of peatland restoration projects 1990-2012 and 2012-2014



Source: Coupar A. (2014) Progress on UK Peatland Action from country levels. Presentation given at 'Peatland Action: Learning from Success Conference 2014', IUCN, Inverness, http://iucn-uk-peatlandprogramme.org/sites/all/files/ProgressonPeatlandAction_ACoupar.pdf; Chapman, S. , James Hutton Institute (2016); ClimateXChange Indicator NB22.

The area of native woodland under restoration has increased significantly, from 400 ha in 2005/06 to over 5,000 ha in 2012/13.[32] This is still, however, below the aspiration of the 2020 Route Map for 10,000 ha to be under restoration. Data collection on this indicator ceased in 2012/13, making it difficult to assess whether the 2020 target is on course to be met.

There are around 40 landscape scale projects in place across Scotland that aim to improve the condition of habitats and species.[33] These range in size from very large projects such as the Coigach–Assynt Living Landscape Project, covering over 60,000 ha, through to smaller projects

[32] Forestry Commission Scotland (2015) *Scottish Forestry Strategy: Progress Report (2014-15).* http://scotland.forestry.gov.uk/images/corporate/pdf/sfs-implementation-plan-2015-2016.pdf

[33] ClimateXChange (2015) NB7: Area of land under landscape scale conservation.

such as the Clyde Valley Woodlands that covers 320 ha along a 12 km stretch of gorge. These projects are run by a range of organisations including conservation charities, government agencies, private estates and community groups. A comprehensive terrestrial habitat map of Scotland is also being developed to better inform and target conservation action.

Is progress being made in managing vulnerability?

The condition of designated sites appears to be improving and progress has been made. However, it is uncertain whether the 80% target in the 2020 Route Map has been fully met.

Under the National Performance Framework (NPF), the Scottish Government reports that 80% of natural features on designated sites were in a favourable condition in March 2016.[34] This has increased from 76% in 2007 and suggests that the aspiration in the 2020 Route Map has been met. However, the NPF indicator includes sites that are currently in an unfavourable condition, but are assessed by SNH as recovering and showing a trend towards favourable condition. The observed increase in favourable condition since 2007 (i.e. from 76% to 80%) is due to features being moved into the recovering category.[35] If the recovering features are excluded, the proportion of sites in favourable condition has slightly declined since 2007 (from 68% to 66%).[36]

The uncertainties with the definitions of site condition raise questions as to whether the 80% target set in the 2020 Route Map has actually been met. There are also questions as to whether SNH's site condition monitoring system is adequately measuring the impact that conservation interventions are having on the condition of sites and natural features. This makes it difficult to robustly track progress being made towards achieving favourable condition.

There is also uncertainty as to whether the assessment of favourable condition sufficiently accounts for climate change, particularly in relation to changing species ranges and distributions. Climate change is currently only reported as a pressure for 0.3% of designated features.[37] It has been argued that current biodiversity monitoring programmes are inadequate for the new challenges presented by climate change.[38] This lack of clarity risks sub-optimal management decisions. Efforts may be focussed on retaining species in locations that are increasingly outside of their climate space. Conversely, insufficient account may be taken of the ability of some species to adapt in situ, if suitable habitat conditions are provided. There is a further risk that a site may be downgraded due to changes in species distributions although the site itself continues to be in a good ecological condition and therefore potentially valuable for colonisation by new species.

There is evidence to suggest that efforts to restore key degraded habitats are starting to deliver improvements in condition.

The proportion of blanket bog features in a favourable condition has increased by 10%, from 68% in 2010 to 78% in 2016.[39] Native pinewood features in a favourable condition also increased by 10% over the same time period. There has been an even more significant improvement in Caledonian forest, from 50% favourable in 2010 to 83% in 2016. However, for all of these habitats the improvements in condition to date have primarily been driven by features moving

[34] http://www.gov.scot/About/Performance/scotPerforms/indicator/naturesites
[35] http://www.environment.scotland.gov.uk/get-interactive/data/protected-nature-sites/
[36] http://www.snh.gov.uk/docs/A1621991.pdf
[37] Defined as either 'Favourable Maintained', 'Favourable Recovered' or 'Favourable Declining'
[38] Scottish Environment LINK (2012) *Preparing Scotland's Environment for a Changing Climate*. http://www.scotlink.org/files/publication/LINKReports/LINKAdaptWkshopReport12.pdf
[39] When defining favourable condition in the same way as the NPF indicator.

from unfavourable to recovering. Sustained restoration efforts will be required over the long-term for recovering sites to eventually be restored to the point where they fully meet favourable status.

Populations of important indicator species are not increasing.

The trends in the condition of indicator species are mixed, with an increase in numbers of terrestrial breeding birds since 1994, but a decrease since the peak in 2008.[40] Numbers of farmland birds saw a steady increase up to the mid-2000s, followed by declines since 2007. Overall abundance in 2013 is not significantly different to that in 1994. Wintering water bird numbers have been relatively stable, although overall abundance in 2012 was lower than in the mid-1970s. There has also been a 61% decline in specialist butterfly numbers, but most of this occurred in the 1980s and 1990s. More recent data (2004-2013) show no clear-cut trend.

RECOMMENDATION 2: The Scottish Government and Scottish Natural Heritage should by the end of 2017 develop the 2020 Route Map into a clear action plan setting out how the outcomes in the Scottish Biodiversity Strategy will be delivered in the context of climate change.

RECOMMENDATION 3: Scottish Natural Heritage should commit to developing a monitoring system by the next SCCAP which can measure (a) the impact of climate change on the condition of sites and species and (b) the effectiveness of conservation interventions, thereby enabling the tracking of progress towards favourable ecological condition.

RECOMMENDATION 4: The Scottish Government and Scottish Natural Heritage should by the end of 2017 establish a target in the Scotland National Peat Action Plan for the area of peatland that will be under restoration by 2030 and introduce and monitor a delivery programme for meeting this target.

[40] http://www.gov.scot/About/Performance/scotPerforms/indicator/biodiversity

2.3.2 Freshwater rivers and lochs

Is there a plan?	 Green	The EU Water Framework Directive requires all water bodies to be in good ecological condition by 2027. The two River Basin Management Plans (RBMPs) that cover Scotland promote a strategic approach to water management. RBMPs include 'climate checks' that consider whether the types of actions required for meeting the WFD targets will need to be amended post-2027.
Are actions taking place?	 Amber	There has been some progress with the implementation of measures in the RMBPs: • SEPA are reviewing water abstraction licences. • Scottish Water is spending £400 million on environmental improvements between 2015 and 2020. However, there has been less progress in some other areas: • Only half of the proposed measures to reduce diffuse rural pollution have been implemented. • Only 10% of water bodies affected by barriers to fish migration have been restored.
Is progress being made in managing vulnerability?	 Amber	Significant improvements to the condition of rivers and lochs have been achieved in recent decades, although progress since 2008 has slowed. Nearly half of all rivers currently fail to meet good ecological status. Despite the review of licenses, over-abstraction is cited as the most significant cause of deterioration in ecological status since 2008, driven in part by the expansion of small hydro-electricity schemes. SEPA projections suggest that 6% of surface water bodies will fail to meet good status by 2027, even if all planned measures are delivered.

Is there a plan?

There is a range of legislation in place to protect and enhance Scotland's water environment. This legislation takes account of the implications of climate change for water availability and quality.

However, adverse pressures such as pollution, physical modification, over-abstraction and invasive species will significantly reduce the resilience of freshwater bodies to the impacts of climate change.

The EU Water Framework Directive, as transposed by the Water Environment and Water Services (Scotland) Act 2003, requires all 3,244 surface water bodies (rivers, lakes, estuaries and coastal

waters) in Scotland to be in good ecological status by 2027. Surface water bodies are assessed on a six-year rolling programme where they are assigned one of five quality classes (bad, poor, moderate, good and high) based on biological and chemical indicators, as well as water flows and levels. A water body that fails against any one indicator is deemed to be below good ecological status.

Implementation of the WFD is co-ordinated at the national scale by the Scottish Environment Protection Agency and delivered through River Basin Management Plans. These contain an agreed programme of measures to address the causes of poor water quality across the two River Basin Districts (RBDs) in Scotland.[41] For water bodies not in good condition in 2008, environmental improvement targets were set for 2015, 2021 and 2027. All water bodies also have the objective of preventing deterioration of condition, whatever their initial status. The RBMPs are produced on a six-yearly cycle, and were published in 2009, and updated in 2015.

Any changes in low or high river flows due to climate change are likely to make it harder to ensure that freshwater bodies remain in good ecological condition in the longer-term (i.e. post-2027). The RBMPs include a 'climate check' of planned actions to assess the extent to which they may help to prepare Scotland's water bodies for the future climate, and to identify whether actions will continue to be effective under changing climatic conditions.

Are actions taking place?

There is mixed progress with the implementation of measures to restore rivers and lochs and reduce adverse pressures on freshwater bodies.

The relevant actions in the SCCAP primarily refer to implementation of the RBMPs, which set out a programme of measures to tackle barriers to fish migration, diffuse and point-source pollution, physical modification, over-abstraction, and invasive species. An assessment in 2013 identified that progress was being made with regard to many measures, but also found that targets for improvement were likely to be missed in a number of areas.

- **Physical condition & fish barriers:** There are more than 300 surface water bodies (around 10% of the total) across Scotland where physical modifications affect their ecological status. There are also around 365 man-made structures known to pose a barrier to fish migration and likely to be affecting the status of fish populations. SEPA together with the Rivers and Fisheries Trusts for Scotland restored fish access to around 10% of affected water bodies between 2009 and 2012.
- **Rural diffuse pollution:** Between 2009 and 2012 a targeted approach to diffuse pollution was taken, focussing intervention in areas where poor land management practices had been identified. Land managers were advised on measures that can reduce diffuse pollution, such as changing the timing of fertiliser application and reducing livestock access to water bodies. However, in the Scotland RBD less than half of the planned improvements to address rural diffuse pollution were on track in the 2013 review and diffuse pollution remains the primary reason for failure in the Solway Tweed RBD.
- **Water flows and levels:** SEPA is in the process of reviewing abstraction licences held by key industries including hydro-electricity, public water supply, irrigation and distilleries. By March 2014, 238 licences had been reviewed, with 53 licence reviews ongoing. Over half (52%) of the reviewed licences were for irrigation, which can pose a significant risk during dry periods.

[41] The Solway RBD and Scotland RBD.

However, in some catchments, particularly in eastern Scotland, abstractions for irrigation can have significant impact on flows and water levels even when conditions have not been unusually dry.

The Water Industry Commission's final determination for the current price review period (AMP6) allowed Scottish Water to spend £401 million on protecting and enhancing the environment between 2015 and 2021.[42] This includes £17 million for direct measures to achieve WFD compliance and £35 million towards meeting the revised Bathing Water Directive requirements. The majority of the investment (£300 million) is towards meeting the Urban Waste Water Treatment Directive.

Is progress being made in managing vulnerability?

The ecological condition of freshwater bodies has improved in recent decades, but progress has been more limited since 2008.

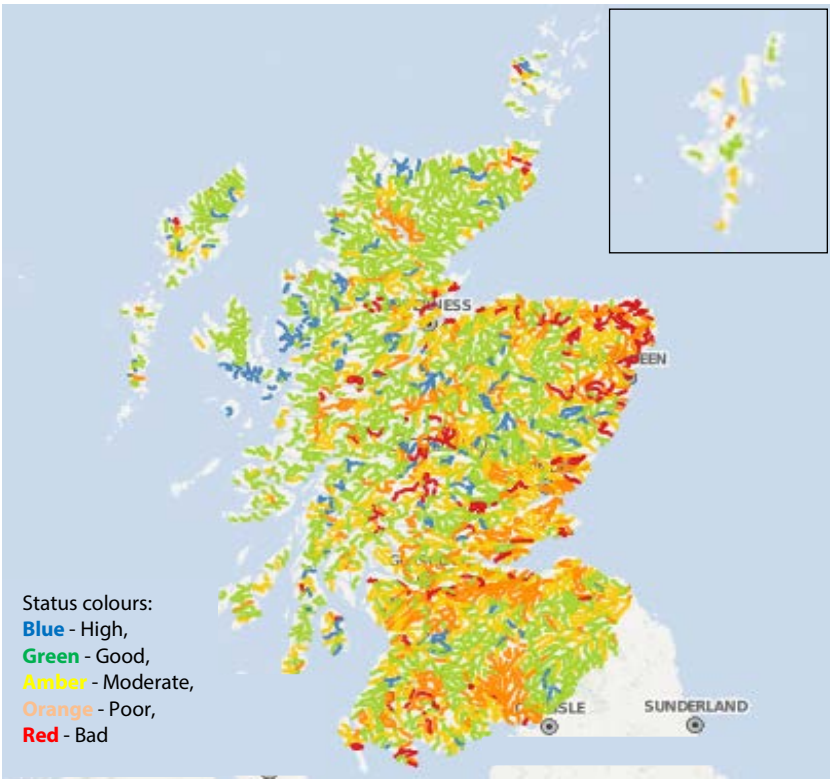
The state of Scotland's water bodies as a whole has significantly improved over the last few decades. In particular there has been progress in preventing and reducing pollution. Between 2000 and 2006 the length of rivers in Scotland affected by pollution was reduced by 37%.[43]

However, the overall proportion of rivers failing to meet good status did not change between 2008 and 2013, remaining at 46%. Of the 2,405 river water bodies in Scotland, the condition of 142 improved between 2013 and 2014, but that of 187 declined. The majority of rivers failing to meet good status are located in the central belt and eastern half of the country (Figure 2.3).

[42] Scottish Water (2015) *Always Serving Scotland Business Plan 2015 to 2021*. http://www.scottishwater.co.uk/assets/about%20us/files/strategic%20projections/swbusinessplan201521march2014.pdf

[43] ClimateXChange (2015) *Progress towards the environmental objectives of the 1st River Basin Management Plans*

Figure 2.3: Ecological status of rivers, 2014



Source: http://www.environment.scotland.gov.uk/get-interactive/data/water-body-classification/
Contains Ordnance Survey Data © Crown Copyright and database right. Licence number 10001699, 2015
Copyright® openstreetmap.org. opendatacommons.org
Notes: Status colours: Blue - High, Green - Good, Amber - Moderate, Orange - Poor, Red - Bad

The condition of lochs has been gradually improving, with the proportion failing to meet good status reducing from 37% in 2008 to 34% in 2014. In contrast to rivers, more lochs improved in condition between 2013 and 2014 than were degraded (55 improving, 21 degrading).

Changes in the assessment methodology used by SEPA make it difficult to assess the significance of these trends. However, SEPA conducted further analysis to distinguish the real change and found that the primary driver of deterioration since 2008 has been over-abstraction, despite the ongoing review of licences. This is likely to be, at least in part, a consequence of the significant expansion of small hydro-schemes between 2009 and 2013. New hydro-schemes accounted for the deterioration in 50 water bodies and compromised the achievement of good status in approximately 90 others.[44]

SEPA expect to see sustained improvements to the condition of water bodies in the Scotland and Solway Tweed RBDs as a result of the actions planned between now and 2027. Projections indicate that by 2027 only 6% of water bodies will not meet good status. Of these failing water bodies, the majority are expected to achieve moderate status, with less than 1% expected to be in a poor condition (29 water bodies in total). In these cases, the costs of meeting good status have been assessed by SEPA as being disproportionate to the benefits.

[44] Some 400 new hydro schemes were authorised during 2009-2013. ClimateXChange (2015) Progress towards the environmental objectives of the 1st River Basin Management Plans.

RECOMMENDATION 5: The Scottish Government and the Scottish Environment Protection Agency should, before the next SCCAP, assess whether the design and operation of the water abstraction regime is compatible with the risk of reduced water availability in coming decades, in a context of projected increases in demand.

2.3.3 Marine and coastal ecosystems

Is there a plan?	 Amber	The EU Marine Strategy Framework Directive (2008) requires Member States to prepare national strategies to manage their seas to achieve good environmental status by 2020. The 2015 Scotland National Marine Plan (NMP) sets out strategic policies for the sustainable development of Scotland's marine resources. Climate change adaptation is embedded in the NMP. Reforms to the EU Common Fisheries Policy requires catch limits to be set that are sustainable and allow fish stocks to be maintained in the long term. The Scottish Government aims for 70% of commercial fish stocks to have quotas set in line with scientific guidance. Shoreline Management Plans are in place for around 4% of the Scottish coastline and a National Coastal Change Assessment commenced in 2014. However, there is currently no national long-term vision or plan proposing the area of intertidal habitat to be created through managed realignment in Scotland.
Are actions taking place?	 Amber	To date, 30 Marine Protected Areas (MPAs) have been designated. Two regional marine partnerships have been established to deliver the National Marine Plan. An aquaculture innovation centre has been established to provide solutions to industry defined problems, including overtopping and fish escapes during storms. To date, only one managed realignment scheme has been delivered in Scotland.
Is progress being made in managing vulnerability?	 Amber	More than half (57%) of Scottish commercial fish stocks have quotas set in line with scientific guidance, which is below the 70% target. There is evidence that damaging fishing practices continue. The average size of fish in trawls in the north west region of the North Sea has been steadily increasing since 2001, albeit from a very low base. Between 1986 and 2012 average seabird populations in Scotland declined by 46%. Progress is being made with improving the condition of designated coastal sites and species and almost all coastal waters meet good ecological status.

Is there a plan?

Legislation is in place at the national and EU level to protect and enhance the marine environment and to manage fisheries. These policies generally account for climate change.

Policies for protecting and enhancing the marine environment and biodiversity are in place, primarily the EU Marine Strategy Framework Directive (2008) and the Marine (Scotland) Act (2010). The MSFD establishes a framework within which Member States are required to "take the necessary measures to achieve or maintain good environmental status" in the marine environment by 2020 at the latest. Implementation of the MSFD may result in the establishment of a marine monitoring programme similar to that for surface water bodies under the Water Framework Directive. If effective MSFD indicators are put in place, then it should be possible to monitor whether Good Environmental Status is being achieved in Scottish waters, although this will depend on the scale at which assessments are conducted. The MSFD has been written with the explicit knowledge that marine systems are dynamic and it includes adaptation and exception sections which require climate and environmental variability to be taken into account.

The Marine (Scotland) Act 2010 provides the legislative framework for marine planning, licencing and conservation. The Act requires the production of a statutory National Marine Plan (NMP), which was published by the Scottish Government in 2015. The NMP sets out strategic policies for the sustainable development of Scotland's marine resources, covering both inshore waters (out to 12 nautical miles) and offshore waters (12 to 200 nautical miles). The NMP provides direction to a wide range of marine decisions and consents, including marine licencing (e.g. for energy development, removals from the seabed; construction works; dredging, etc), commercial fishing licencing and aquaculture development consents: The NMP includes a general policy that "marine planners and decision makers must act in the way best calculated to mitigate, and adapt to, climate change". The Plan notes that marine planners should use climate projections to assess impacts on marine ecosystems and highlights the UK Climate Change Risk Assessment as the key evidence base. Adaptation to climate change is also embedded within all the sector specific policies in the NMP, including policies on Sea Fisheries where improving knowledge of the impacts of climate change on fish stocks and their ecosystems, and improving the health of stocks and ecosystem resilience are stated as priority objectives.

Marine planning will be implemented at a local level within Scottish Marine Regions that cover in-shore waters. These are currently being developed by marine planning partnerships. The NMP requires regional marine plans to "explain how they have taken into account future climate change in terms of climate change adaptation".

The 2010 Act also provides for the establishment of an ecologically coherent network of well managed Marine Protected Areas (MPAs) in the North East Atlantic. These sites protect a representative range of habitats and species in Scotland's seas. The Act includes powers to designate MPAs that will complement existing designations, such as Natura 2000 sites (SPAs and SACs) and marine components of SSSI and Ramsar sites. These protected sites and areas should make a significant contribution to the protection, enhancement and health of Scotland's marine environment. The NMP requires that the management objectives for each type of designation must be met, although it does not explicitly refer to how climate change impacts should be accounted for in their notification and management. A recent review of the Scottish MPA

designation process also found that there has been limited consideration of climate change in selecting sites for the first iteration of the MPA network.[45]

The impact of climate change is one of the factors considered when quotas are set under the EU Common Fisheries Policy. Quotas can be swapped each year between member states and used if distributions of managed stocks shift into new areas, or retreat from traditional ones. However, in practice such swaps are not always straightforward to negotiate or implement. The Scottish Government aims for at least 70% of commercial stocks to have quotas (described as the Total Allowable Catch) that are consistent with scientific guidance.

Key organisations in the sector have recently reported under the Adaptation Reporting Power. These include Seafish, a non-departmental public body set up by the Fisheries Act 1981 to raise standards across the UK seafood industry. The Scottish Marine Science Strategy (2010 - 2015) sets three priorities, one of which is 'responding to climate change and its interaction with the marine environment'.

Policies for managing coastal change are not well developed.

Shoreline Management Plans are in place for Fife, Angus, East Lothian, and Dumfries and Galloway. Together these cover around 4% of the Scottish coastline (693km out of 19,000km). These plans aim to provide long term sustainable management of coastal zones, including protecting and restoring coastal habitats such as saltmarsh, machair and sand dunes. A National Coastal Change Assessment commenced in 2014 that aims to develop a shared evidence base on coastal change across Scotland, starting with a mapping exercise for the entire Scottish coastline.

SEPA's Flood Risk Management Strategies (FRMS) aim to influence local authorities to choose natural flood management (NFM) solutions, including managed realignment, as a sustainable approach to coastal flood protection. However, there is currently no national long-term vision or plan for the area of intertidal habitat to be created through managed realignment in Scotland.

Are actions taking place?

There is evidence of action being taken to increase the resilience of the marine environment, including through improving fishery practices and the designation of Marine Protected Areas.

The relevant policies and proposals in the SCCAP focus on the delivery of the National Marine Plan and the development of regional marine partnerships. The first two partnerships have been established in the Clyde (although this is not yet fully operational) and Shetland regional areas. The SCCAP also refers to implementation of the Common Fisheries Policy, including an industry-led initiative to improve the targeting of commercial fish species by using appropriate fishing gear and decreasing discards.

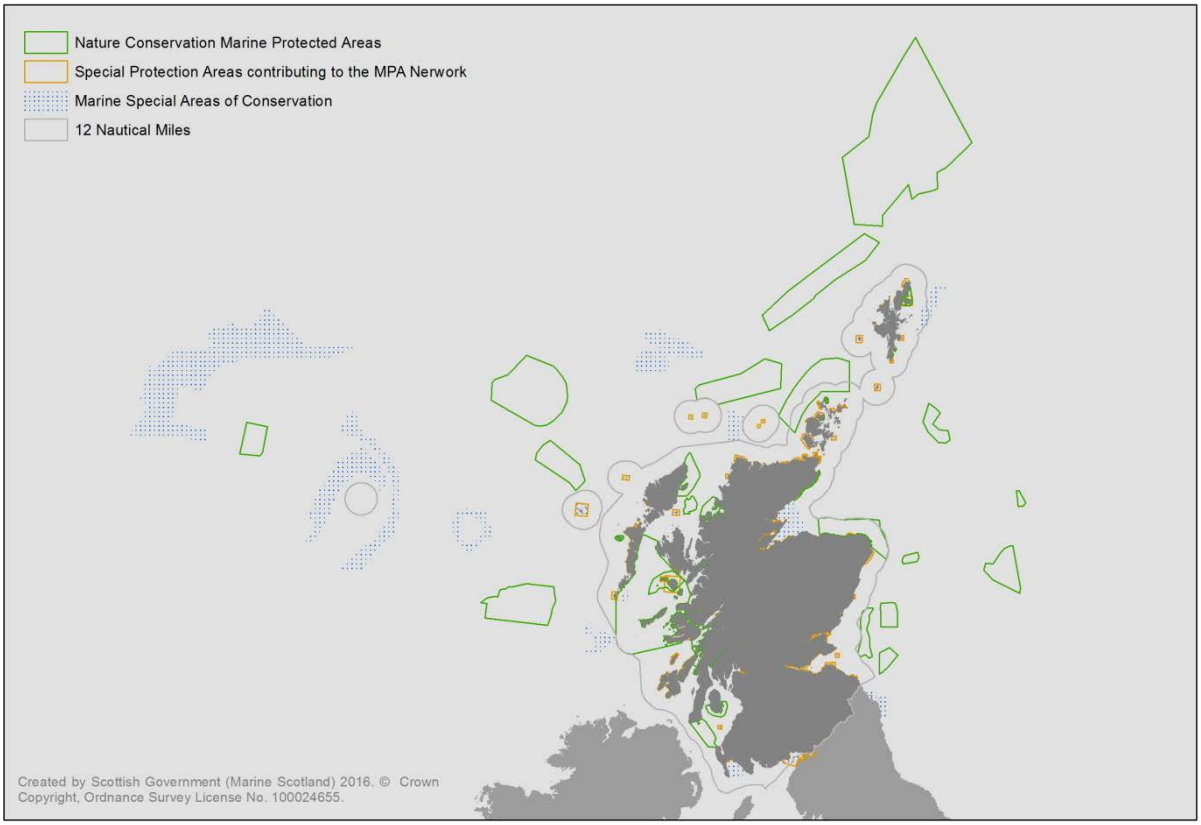
Progress is being made in the establishment of a network of Marine Protected Areas, with the designation of 30 MPAs in 2014 meaning that 20% of Scottish waters are protected (Figure 2.4) Also in 2014, Scottish Natural Heritage recommended that the Scottish Government should proceed with the designation of a further four MPAs in areas considered important hotspots for

[45] Hopkins et al (2016) *Scotland's Marine Protected Area network: Reviewing progress towards achieving commitments for marine conservation*. Marine Policy 71.

species of whale, dolphin, porpoises and basking sharks.[46] A number of environmental groups are calling for these remaining MPAs to be designated in order for the network to be complete.[47] However, to date the Scottish Government has not responded to SNH's recommendation.

An aquaculture innovation centre has been established to provide solutions to industry defined problems, including overtopping and fish escapes during storms. SEPA has also developed a new model to predict the impact of aquaculture on the environment, which includes climate change impacts.

Figure 2.4: Marine SPAs, SACs and MPAs within Scottish waters



Source: Marine Scotland (2016).

There is limited action being taken to deliver managed realignment and habitat creation on the coast.

To date, only one managed realignment project has been completed in Scotland and this was in 2003.[48] More than a decade later there has been very little progress with any further managed realignment or coastal habitat recreation projects. The RSPB have identified the potential to

[46] Scottish Natural Heritage (2014) *Further advice to Scottish Government on the selection of Nature Conservation Marine Protected Areas for the development of the Scottish MPA network*. SNH Commissioned Report No. 780. http://www.snh.org.uk/pdfs/publications/commissioned_reports/780.pdf

[47] http://www.savescottishseas.org/news/whales-dolphins-and-basking-sharks-need-mpas-now/

[48] Nigg Bay in the Cromarty Firth. See RSPB (2016) *Glorious Mud - homes for nature, protection for people*. https://www.rspb.org.uk/Images/glorious-mud_tcm9-415616.pdf

realign 66 relatively small sections of the Scottish coast that, if delivered, would create over 4,000 ha of new saltmarsh and intertidal habitats.[49]

There are very few funding sources that support habitat creation through managed realignment. SEPA's Flood Risk Management Strategies (FRMS) mainly focus on actions to reduce the vulnerability of people and property. This approach arguably underplays the importance of large stretches of Scotland's sea and tidal estuary coastline, which are vulnerable to flooding although with a low risk to people or property. The decision making process remains in the hands of local authorities through Local Flood Risk Management Plans.

Scotland's Rural Development Programme (SRDP) includes an option which provides funding for land owners to remove sea walls in order to allow the inundation of a defined area of land. However, the SDRP cannot fund construction of secondary coastal defences further inland, so is limited in its contribution to the overall cost of any managed realignment project.

Is progress being made in managing vulnerability?

While some indicators appear to be heading in a positive direction, there are also a number of long-term trends that suggest the vulnerability of the marine environment to climate change may be increasing.

- **Fisheries:** In 2015, 57% of Scotland's key commercial fish stocks had quotas (described as the Total Allowable Catch) set in line with scientific guidance. This was below the 70% target. However, this is a significant improvement on 2014 when only 40% of stocks had TACs that were consistent with scientific guidance.[50] There is also evidence of a sustained increase in the proportion of large fish (40cm or greater in length) in trawl catches in the north-western North Sea, increasing from 2% in 2001 to 22% in 2014.[51] The evidence therefore suggests that pressures on commercial fish stocks from unsustainable practices may be reducing, although there is still progress to be made. Many fishing methods continue to pose a threat to non-target species and marine habitats. For example, marine mammals, sharks, turtles and seabirds are often caught as by-catch in purse seine, mid-water trawl, drift and gill nets and on longlines, whilst dredging and bottom trawling can cause extensive damage to the sea bed. Significant concerns remain over the status of threatened and vulnerable species such as sharks, skates and rays, and deep sea species. There are also concerns over diadromous fish species, such as the European eel and salmon, which move between fresh and salt water during their lifecycle.
- **Planktonic ecosystems:** There have been extensive changes in planktonic ecosystems in terms of overall plankton production, biodiversity and species distribution. In the North Sea the population of the previously dominant and important zooplankton species, the coldwater species Calanus finmarchicus, has declined in biomass by 70% since the 1960s. Species with warmer-water affinities are moving northward to replace the declining coldwater species, but are not as abundant or as nutritionally important (i.e. less lipid-rich).

[49] The 66 sites are primarily located in four main areas; the Firth of Forth, the Solway, the Tay and the area of the Cromarty, Beauly & Dornoch Firths. See RSPB (2016).

[50] The main reason for this increase is the 2016 TAC for mackerel being set in accordance with scientific guidance guided by a new internationally agreed Long Term Management Strategy for the stock. In addition, a TAC for North Sea herring that respects scientific guidance has also been set in 2016. See http://www.gov.scot/About/Performance/scotPerforms/indicator/marine

[51] UK Biodiversity Indicators –. D1a. Fish size classes in the North Sea. http://jncc.defra.gov.uk/page-4248

These changes to the base of the marine food chain could have very substantial implications for fisheries and biodiversity.

- **Marine mammals:** UK seas host 38% of the world's population of grey seals and 30% of the European population of harbour (or common) seals.[52] Grey seals are generally experiencing few problems and populations are increasing in some areas. The conservation status of the 28 species of cetaceans regularly found in UK waters is classed as favourable.
- **Seabirds:** Between 1986 and 2012 average seabird populations in Scotland declined by 46%, with the Northern Isles seeing the most significant declines.[53] Breeding failures were reported in a number of colonies in 2012, especially kittiwake colonies. The reasons behind declines in seabird abundance are complex, involving a combination of changing food availability, climate change and the impact of non-native species. Changes lower down the food chain caused by increasing sea temperatures are thought to have contributed to reductions in the abundance, size and energy content of seabird prey species, such as small shoaling fish.

Progress appears to be have been made with improving the condition of designated coastal sites and species, although concerns have been raised regarding saltmarsh habitat. Almost all coastal waters and a high proportion of estuaries meet good ecological status.

There has been a sustained increase in the proportion of coastal sites and species in favourable or recovering condition, from 81% in 2010 to 88% in 2016.[54] According to SNH site condition monitoring data, 90% of designated saltmarsh sites are currently in a favourable or recovering condition.[55] However, the first detailed comprehensive national survey of saltmarsh habitat in Scotland found that 67% of the 7,700 ha assessed failed to meet one or more condition criteria.[56] Designated sites were in a worse condition than non-designated, with 69% of SSSI sites and 72% of SAC sites failing targets compared to 65% of non-designated sites. The main reasons for failure related to the presence of built structures such as embankments.

The proportion of Scottish coastal waters meeting good ecological status under the Water Framework Directive has increased, from 93% in 2008 to 97% in 2014. However, the proportion of estuaries meeting good status has not changed since 2008, remaining at 86%.

RECOMMENDATION 6: The Scottish Government should assess by the end of 2017 the implications of increases in marine water temperatures and acidity (both actual and projected) for marine ecosystems, the MPA network, and the commercial fisheries and aquaculture sectors.

RECOMMENDATION 7: The Scottish Government should, by the end of 2017, set a long-term target for the area of intertidal habitat to be created through managed realignment in Scotland and introduce appropriate policy mechanisms to achieve it.

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52 http://www.smru.st-andrews.ac.uk/documents/1199.pdf

53 ClimateXChange (2015) NB6a/NB17a: Abundance and productivity of breeding seabirds.

54 http://www.environment.scotland.gov.uk/get-interactive/data/protected-nature-sites/

55 Ibid.

56 From 2010-2012 all known saltmarshes larger than 3ha were surveyed across the Scottish mainland and offshore islands. See Haynes, T (2016). *Scottish saltmarsh survey national report*. Scottish Natural Heritage Commissioned Report No. 786.

2.3.4 Soils and agriculture

Is there a plan?	 Amber	The Scottish Rural Development Programme (SRDP) under Pillar II of the EU Common Agriculture Policy (CAP) includes a dedicated agri-environment climate scheme. The Scottish Soils Framework has the aspiration that all soils are safeguarded for future generations. The Land Use Strategy establishes a series of principles for sustainable land use, but the mechanisms for implementation on the ground are at an early stage of development. A Scottish Government discussion document on the future of Scottish agriculture does not explicitly address the risks, or potential opportunities, from climate change.
Are actions taking place?	 Green	The SRDP incentivises measures to reduce soil erosion, although uptake is mixed and damaging practices continue. A programme has run since 2009 promoting sustainable farming practices and increasing adaptive capacity. Guidance is available to farmers on managing climate change impacts. Research is underway into the future risks from pests and diseases, and possible adaptation measures.
Is progress being made in managing vulnerability?	 Red	There was a measured decrease in the soil carbon content of arable land in Scotland between 1998 and 2007. Some parts of eastern Scotland have seen an increase in soil aridity and erosion rates between 1980 and 2000. The proportion of arable land left bare and so at high risk of erosion increased from 15% in 2010 to 19% in 2013. There is evidence that some agricultural pests and diseases, such as liver fluke and potato blight, are on the increase.

Is there a plan?

Policies are in place to incentivise farming practices that will increase the resilience of agriculture to climate change.

The primary policy mechanism affecting agricultural land-use in Scotland is the EU Common Agricultural Policy. Under Pillar I, land-holders receive a direct payment to maintain their land in Good Agricultural and Environmental Condition. Under Pillar 2, over £1.1 billion has been allocated to fund the Scotland Rural Development Plan for the period 2015 to 2020. Around one-third of agricultural land is covered by the SRDP which has four main funding categories:

- £445 million (38%) for marginal areas facing natural constraints, including support for crofting;
- £268 million (23%) for forestry and woodland management;
- £256 million (22%) for the Agri -Environment Climate Scheme; and
- £206 million (18%) for investment in physical assets e.g. property, industrial buildings or equipment.

There are a range of options under the Agri-Environment Climate Scheme that are making an important contribution to adaptation, including supporting appropriate management for species and habitats, strengthening ecological networks, controlling invasive non-native species, implementing natural flood risk management, reducing diffuse pollution of water bodies and enhancing the condition of protected sites.

The Scheme is also contributing to Scotland's climate change targets through measures to reduce greenhouse gas emissions from agriculture and secure carbon stores in peatlands and other organic soils. However, it has been suggested that the Scheme could go further by, for example, incentivising alternate use of crops and crop rotations, carbon auditing and soil protection measures.[57]

A Soils Framework was established in 2009 to co-ordinate actions to promote good soil management. It describes key pressures, particularly climate change, and relevant policies to combat the threats. The framework's vision is that soils are recognised as "a vital part of the Scottish economy, environment and heritage to be safeguarded for existing and future generations".

Scotland is alone in the UK in having a statutory Land Use Strategy (LUS). This sets a strategic vision to 2050 for a *"Scotland where we fully recognise, understand and value the importance of our land resources, and where our plans and decisions about land use will deliver improved and enduring benefits, enhancing the wellbeing of our nation."* The LUS establishes high-level objectives for strategic land use policy relating to economic, environmental and community sustainability. Ten cross-sectorial principles for sustainable land use are set out, which are embedded into Scottish Planning Policy in order to inform everyday land-use decisions and choices. One of the ten LUS principles relates to climate change, stating:

Land-use decisions should be informed by an understanding of the opportunities and threats brought about by the changing climate. Greenhouse gas emissions associated with land use should be reduced and land should continue to contribute to delivering climate change adaptation and mitigation objectives.

The LUS was first published in 2011 and is required under the Climate Change (Scotland) Act 2009 to be updated on a five-year cycle. The second LUS covers the period 2016 to 2021, with the Vision, Objectives and Principles for Sustainable Land Use unchanged from 2011. There are, however, a number of new policies and proposals to implement the second LUS, including on agriculture where the aim is to "develop and implement a package of measures to facilitate the step change to climate friendly farming and crofting."

The Scottish Government recognises the challenge of translating the high level vision and objectives in the LUS into tangible change on the ground. Two regional land use framework

[57] Ecologic Institute et al (2014) *Mainstreaming climate change into rural development policy post 2013* http://ecologic.eu/10439

pilot projects were established in 2013 in Aberdeenshire and the Scottish Borders to test the practicality of applying the ten LUS principles in local decision making. The second LUS includes a proposal to explore the further development of regional land use partnerships in other rural areas of Scotland, initially through preparing guidance by the end of 2017. However, the extent to which regional land use frameworks and partnerships will be developed across Scotland is not yet clear at this stage.

The Scottish Government published a 'discussion document' on the future of Scottish agriculture in 2015, which sets out its aspirations for a "greener, innovative and profitable agricultural industry."[58] The importance of a resilient sector that is able to deal with shocks, including from climate change, is noted. However, there is no reference to realising the potential benefits from climate change, such as from longer growing seasons, nor to the need to ensure sustainable land management responses to changing climatic conditions.

Are actions taking place?

There is evidence of action being taken to increase the resilience of agricultural systems, although data on the level of uptake of key measures is lacking.

A number of measures being implemented under the Agri-Environment Climate programme are helping to reduce the risk of soil erosion, including:

- Creation of grass strips and water margins in arable fields.
- Conversion of arable land at risk of erosion or flooding to low input grassland.
- Retention of winter stubbles followed by green manure in an arable rotation.

In 2013, 11% of arable land in Scotland was under a reduced tillage regime (defined as any system that leaves a minimum of 30% crop residue as soil cover) and 8% under zero tillage (i.e. direct drilling). Conventional inversion tillage is used on the remaining 81% of arable land. There was a very slight increase in the use of cover crops, from 2% to 3%, between 2010 and 2013.

A Scottish Government programme, 'Promoting farming for a better climate', provides advice on the projected impacts of climate change and on the adaptation measures that can be taken. The programme has been running since 2009, delivering workshops and developing case studies on resilience planning, including on heat-stress, wet weather and flooding. A series of on-farm training events led by experts at locations around Scotland have been held for people employed in farming, food and forestry. The Soil Association's Future Farming Scotland is a similar initiative, which •provides information, events and 'field labs' on soil, nutrient and grassland management; animal health and productivity; woodland creation and management; and organic farming.[59]

A Knowledge Transfer and Innovation Fund under the SRDP includes a 'Future Proofing Scotland's Farming' innovation network. This programme supports the implementation of priority measures including climate change adaptation. Research is also ongoing to explore the feasibility of crop strains that could survive in higher average temperatures. The James Hutton

[58] Scottish Government (2015) *The Future of Scottish agriculture: a discussion document*. http://www.gov.scot/Publications/2015/06/6695

[59] https://www.soilassociation.org/farming-growing/support-for-you/future-farming-scotland/

Institute is carrying out research to identify potential threats from new or existing pests and diseases as a result of climate change, and possible approaches to mitigate those risks.[60]

The Plant Biosecurity Strategy for Great Britain contains six direct actions for climate change adaptation, of which some are relevant to Scotland. The UK Action plan for Animal and Plant Biosecurity also includes relevant actions in relation to import controls.

Is progress being made in managing vulnerability?

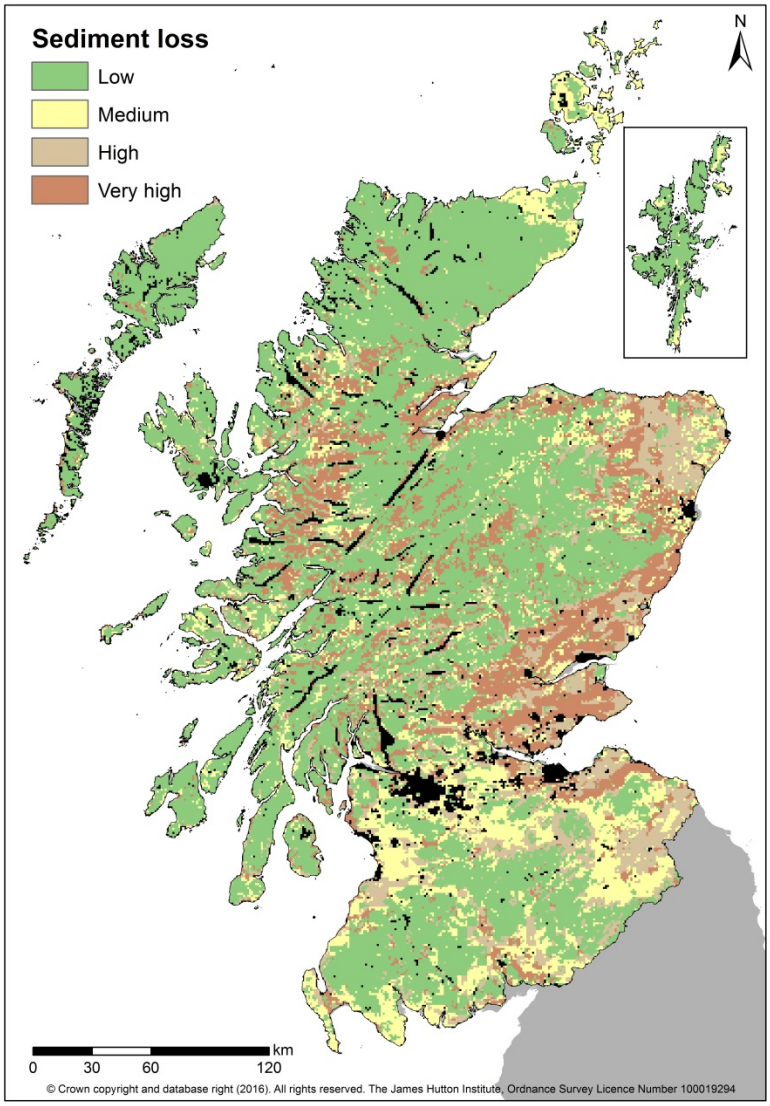
The available data suggest that the vulnerability of agricultural soils to climate change is likely to be increasing.

Between 1998 and 2007 there was a 9% decline in the mean soil carbon concentration in arable and horticultural soils in Scotland, from 36 g/kg in 1978 to 32 g/kg in 2007.[61] The drivers of this statistically significant reduction include climate change, nutrient deposition, agricultural intensification, increasing atmospheric CO_2 concentrations, and land use change. Overall, agricultural intensification is likely to be the dominant factor.

Whilst soil erosion rates across Scotland are not known, local studies have found increases in patterns of erosion.[62] Drought risk is a proxy indicator for erosion as arid soil is more likely to be blown or washed away. Some parts of eastern Scotland have seen an increase in soil aridity and drought risk between 1980 and 2000. Soil erosion modelling suggests that the eastern central lowlands have the highest risk of soil erosion (Figure 2.5). The proportion of arable land left bare and so at high risk of erosion from wind and rain increased from 15% in 2010 to 19% in 2013.

60 http://www.scri.ac.uk/research/climatechange
61 ClimateXChange (2015) NA11 Soil carbon concentration in arable soils.
62 ClimateXChange (2015) Soil erosion risk.

Figure 2.5: Soil erosion risk



Source: Baggaley N.J. & Lilly A. 2011. Estimated sediment losses due to water erosion in Scotland using the PESERA soil erosion risk model. In: Dobbie, K.E., Bruneau, P.M.C and Towers, W. (eds) 2011. The State of Scotland's Soil. Natural Scotland, www.sepa.org.uk/land/land_publications.aspx. Based on work in work by Lilly, A. et al. 2009. Climate change, land management and erosion in the organic and organo-mineral soils in Scotland and Northern Ireland. Scottish Natural Heritage Commissioned Report No.325 (ROAME No. F06AC104 - SNIFFER UKCC21). ClimateXChange Indicator NA10.
Notes: The Pan European Soil Erosion Risk Assessment model (PESERA), developed by Kirby, et al. (2004), has been applied nationally and suggests annual erosion rates less than 1 t ha-1 for the majority of Scotland under current (1971-2000) rainfall patterns and land uses, although the model potentially predicts greater losses for the arable areas of eastern Scotland (>2 t ha-1 yr-1) depending on which crops are grown.

The incidence of some pests and diseases affecting agricultural production may also be increasing.

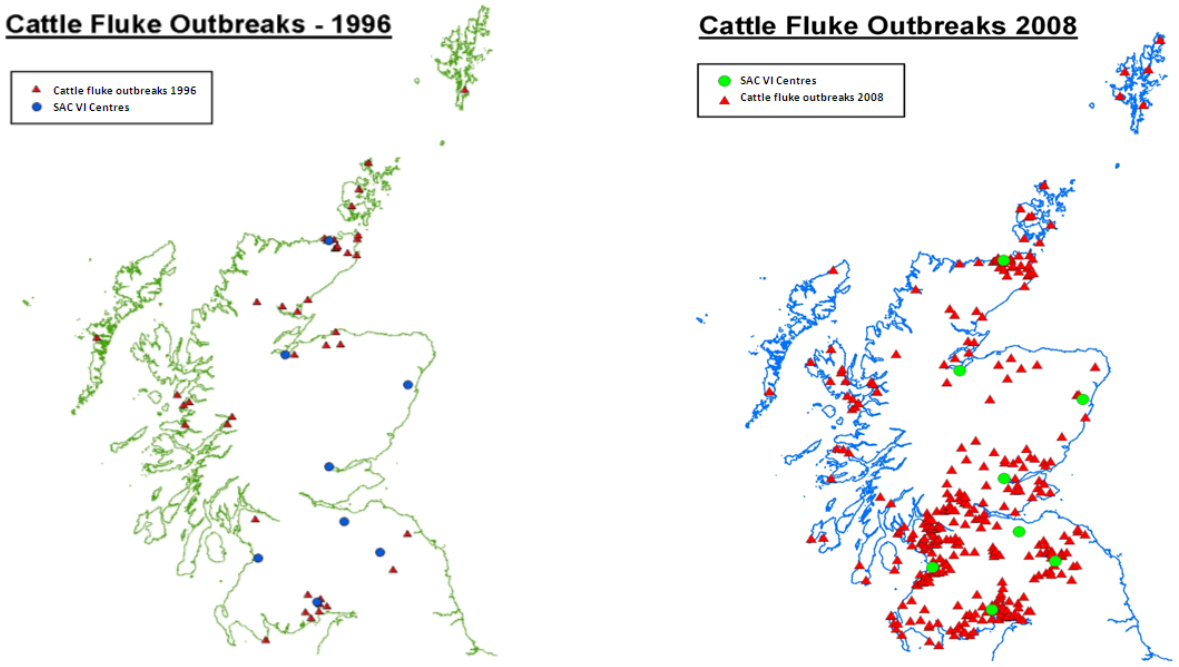
Seed and ware potato production is an important industry in Scotland particularly in the east of the country from Edinburgh to Inverness. Potato late blight is one of the main threats to the

potato crop during the growing season (April to October). Disease epidemics are driven by weather conditions, with periods of high humidity, dew and rainfall and moderate temperatures (13-16°C) being optimal for pathogen infection and spread. If unchecked the disease can result in total crop loss within 7 to 10 days. The number of outbreaks has increased slightly across Great Britain since 2003, although there is a significant amount of variability making it difficult to decipher long-term trends. However, approximately 40,000 more hectares of potatoes in Scotland were treated with fungicides in 2012 than in 2010, which is likely to be an indication of increased disease pressure.[63]

There has also been a consistent increase in liver fluke incidence in Scotland in recent decades, from 3% and 1% in cattle and sheep, respectively, in 1993 to 16% and 17% in 2013. The liver fluke is a highly pathogenic flatworm parasite of sheep and cattle. Animals become infected while grazing on pasture by ingesting fluke cysts shed by infected mud snails. Fluke can be particularly devastating in sheep and was responsible for considerable disease and death amongst sheep in Scotland in the winter/spring of 2012-2013. As well as death of livestock, fluke also causes significant production losses e.g. reduced live weight gain in sheep and cattle, poor reproductive performance and reduced milk yield in dairy cattle. Liver fluke has been an issue for farmers for many decades, especially in the wetter west of Scotland; however it has more recently spread into eastern and north-eastern areas (Figure 2.6). Changing weather patterns, specifically wet summers, mild winters and, possibly, flooding events, are likely to be one of the main drivers of changing incidents of liver fluke but they are not the only explanation of recent changes. Animal movements contribute significantly to the spread of the parasite around the country and its establishment in previously fluke-free areas, especially if bought-in livestock are not given an effective quarantine fluke treatment. The emergence of flukicide resistance is also a contributory factor in the inability to control the parasite in endemic areas.

[63] ClimateXChange (2015) NA25 Range and prevalence of climate marker pests and diseases in crops: Number of potato blight outbreaks.

Figure 2.6: Cattle fluke outbreaks in Scotland, 1996 and 2008



Source: SAC Veterinary Investigation Centres (2008). ClimateXChange indicator NA26.

RECOMMENDATION 8: The Scottish Government should take action to deliver the vision in its Soils Framework that "soils are safeguarded for existing and future generations". An action plan should be published before the next SCCAP, which includes proposals for: establishing a scheme to monitor the health of agricultural soils and the uptake of soil conservation measures, and taking enforcement action where poor management practices are found.

2.3.5 Forestry

Is there a plan?	 Green	The UK Forestry Standard references two voluntary measures for forest management that aim to increase resilience to climate change. Guidance documents have been developed for foresters and research is underway to assess the climate suitability of species beyond 2080.
Are actions taking place?	 Green	There has been an increase in the use of the Forestry Commission Scotland's decision support tools. Actions are being taken to manage deer and reduce the spread of pests, pathogens and invasive species.
Is progress being made in managing vulnerability?	 Amber	There has been an increase in the proportion of the national forest estate comprising broadleaved species since the mid-1990s. However, Sitka spruce and Scots pine remain the dominant conifer species used. This lack of diversity potentially increases the vulnerability of Scottish forestry to other climate impacts. The geographic spread of some tree pests and pathogens has increased significantly in recent years, with potentially major consequences for forestry and biodiversity.

Is there a plan?

Clear plans and standards for forest management are in place. These explicitly account for climate change.

The 2006 Scottish Forestry Strategy both looks ahead to the second half of the century and focusses on key priorities over the next decade. Climate change is an overarching theme, with the stated aim of "using forestry, and adapting forestry practices, to help reduce the impact of climate change and help Scotland adapt to its changing climate".

The UK Forestry Standard provides the reference for sustainable forest management in the UK. It includes two voluntary measures that are important for adaptation:

- Forest management should maintain or enhance the resilience of forests and forest ecosystems in order to reduce the risks posed by climate change to their sustainability.
- Forest management should enhance the potential of forests to protect society and the environment from the various effects of climate change.

Whilst the above approaches are voluntary, there are also a number of mandatory actions in the Standard relevant to adaptation, such as increased woodland management. The Standard is due to be reviewed and updated by end of 2016.

The Scottish Rural Development Programme aims to encourage a range of woodland types as well as support silviculture. Over one-fifth (23%) of the £1.1 billion budget is due to be spent on supporting Scottish forestry between 2015 and 2020. The SDRP includes support for forest managers to take preventative measures to discourage the spread of pests and pathogens, as well as support for replanting affected areas.

Forestry Commission Scotland (FCS) published a Climate Change Plan in 2013 covering the National Forestry Estate, which makes up nearly half (46%) of all Scottish forests. The plan includes guidance on increasing diversity in Scotland's forests and sets out actions to increase resilience, including through deer management and wildfire prevention. The Forestry Commission published guidance on building wildfire resilience into forest management planning in Great Britain in 2014.

FCS has also produced a Dothistroma Needle Blight Action Plan to limit the spread and potential impact of DNB on Scottish forestry. The plan, which is reviewed annually, aims to increase awareness, research and detection effort as well as encourage preventative measures including the destruction of infected plants in nurseries, the establishment of buffer zones around native Caledonian pinewoods, and the felling of infected stock. Further planting of Corsican and Lodgepole pine is not recommended and has been suspended in many areas of the National Forest Estate. In addition, no Scots pine is planted within 550m of where DNB has been detected or in Caledonian pinewood areas. The main management option to minimise infection is to ensure that all stands are kept well thinned to facilitate air movement and to lower humidity in the canopy, as well as monitoring the condition of infected stands and felling them when they are at highest risk of spreading DNB.

Phytophthora ramorum (Pr) is a fungus-like pathogen, which has caused significant tree damage and mortality in the USA (where it is known as Sudden Oak Death). Statutory Plant Health Notices (SPHNs) are issued by the Forestry Commission in affected areas. These require the felling of infected trees and those in a surrounding buffer zone. SPHNs are part of a suite of biosecurity measures being used to prevent the spread and minimise the impact of Pr in Scotland. FCS published an Action Plan for Pr on Larch in Scotland in 2013. However, the extent and rate of spread of Pr in Dumfries and Galloway meant it was no longer considered feasible to use SPHNs for the felling of infected larch in this area. A new regulation was introduced, the Plant Health (Forestry) (Phytophthora ramorum Management Zone) (Scotland) Order 2014, which provides 'special arrangements' for movement of larch within a designated Management Zone, along with statutory controls on any potentially infectious timber and timber products leaving the area.

Are actions taking place?

Guidance and research has been produced and, practical actions are being taken to manage deer and reduce the spread of invasive species, pests and pathogens.

An online decision support tool, the Ecological Site Classification Decision Support System (ECS), enables forest managers to consider what species may be ecologically suited to their sites both now and in the future. The number of users of the tool increased from 4 in 2008 to 151 in 2012.[64] ECS is promoted through Forestry Commission Scotland and Forest Research's climate change adaptation guidance and training programme.

[64] ClimateXChange (2015) NF6: Number of uses and users of the Ecological Site Classification decision support tool.

FCS and Forest Research also promote the use of ForestGALES, a decision support tool that helps plan forest planting to minimise windthrow risk. The tool is used by both the private forest sector and in the National Forest Estate. The number of users of the Forest Gales tool has increased from 55 in 2009 to 124 in 2012.[65]

Deer management is vital for effective woodland management and to secure biodiversity objectives. Deer grazing is one of the key pressures affecting natural regeneration and the establishment of native and non-native woodlands. The area of woodland with active, approved deer management plans in place has increased by 17% between 2007 and 2013 from 665,000 ha (50% of total woodland area) to 779,000 hectares (55% of total woodland area).[66]

Since the mid-1990s there has been a significant increase in the scale of rhododendron clearance efforts, helped by funding through the EU LIFE Nature Programme, the European Regional Development Fund, the Scottish Rural Development Programme, and Scottish Natural Heritage discretionary funds. The LIFE project was targeted specifically at restoring Atlantic oakwoods and included a six year control programme at Sunart and Loch Maree.

In 2014/15, 22 forest sites were issued with a Statutory Plant Health Notice for Pr and around 130 hectares of woodland were felled. This was lower than in 2012/13, when there were 123 SPHNs and 400 hectares felled.

New research into tree health and security is ongoing. The research programme 'PROTREE' is exploring the role of the extent of genetic variation in determining Scots pine's resistance to pests and disease threats, using new and existing field trials. Research has been undertaken to identify the invasive non-native species most likely to arrive in next ten years. A National Woodland Survey for Scotland, initiated in 2014, gathers data on the number of woodland units where INNS are present.

Is progress being made in managing vulnerability?

There has been some progress with diversifying the species composition of the National Forest Estate.

Given the uncertainty surrounding future climatic conditions, increasing the diversity of the tree stock provides a measure of insurance against a range of outcomes. Greater diversity of species also makes woodland potentially more resilient to pest and disease outbreaks. Additionally, there are benefits for climate change mitigation from increasing the proportion of broadleaved species, as conifers located in northern latitudes may contribute to warming due to the albedo effect.

The current timber industry in Scotland is based overwhelmingly on softwoods, particularly Sitka spruce. Three-quarters of the 1.4 million hectares of forest comprise conifers, with Sitka spruce accounting for 43% of total forest area. This reflects market demand for a variety of Sitka spruce products, such as pallets, picket fencing and paper. According to the Scottish Forestry Strategy, maximising the value of Sitka spruce "represents a huge opportunity for Scotland."

Scots pine is the next most significant species, accounting for 13% of the total forest area. Birch is the predominant broadleaf species, comprising 11% of total forest area.

[65] ClimateXChange (2015) NF21: Number of uses and users of the ForestGALES decision support tool.
[66] ClimateXChange (2015) NF14: Area of woodland with active, approved deer management plans.

Overall tree species diversity in the Scottish public forest estate increased between 1995 and 2014, primarily due to the addition of a higher proportion of broadleaved species. The area of conifer forest decreased, from 82% in 1995 to 75% in 2014, and broadleaf forest increased from 18% to 25%. There has, however, been minimal change in the conifer species mix, with the dominance of Sitka spruce slightly increasing from 57% in 1995 to 59% in 2014. The majority of Sitka spruce (80%) and Scots pine (78%) areas are projected to remain climatically suitable in the 2050s. The average rotation period for commercially grown Sitka spruce is also relatively short (35-45 years).[67]

More generally, there is minimal evidence of increasing diversity in the stock of new trees ordered for planting in Scotland. Sitka spruce accounted for 75% of the 25 million new conifer trees ordered in 2012 for both private and public sector forests.[68]

The increasing incidence of tree pathogens and non-native invasive species in Scottish forests is a significant concern.

Dothistroma needle blight (DNB) has become the most significant disease affecting coniferous trees in the UK. The fungus affects the needles of the infected tree, which are eventually shed. As this continues, year on year, the tree will weaken, significantly reducing timber yields. It can also lead to mortality. Whilst DNB was first recorded in the UK in the 1950s, it was not known in Scotland until 2002. The reasons for the increase in disease incidents are unclear, but could be due to increased rainfall in spring and summer coupled with a trend towards warmer springs, optimising conditions for spore dispersal and infection.

DNB has now been detected in over 11,000 ha of pine woodland on the Scottish national forest estate, including in Corsican, Lodgepole and Scots pine.[69] There has been a six-fold increase in the number of commercial Scots pine sites within 1km of a known outbreak of DNB, from 9% in 2007 to 61% in 2013.[70] The majority of DNB infected forestry is in the north and north east of Scotland, with over half of all infections in the North Highland district (Figure 2.7). DNB also remains a serious cause of concern for tree nurseries, with potential implications for the future supply of planting stock for the forestry sector. The number of native Caledonian pine sites exposed has increased by a factor of twenty, from 84 sites in 2007 to 1,614 sites in 2013. As noted above, native pinewoods have a poor regeneration record, and there is concern that impacts of DNB on young trees could further threaten age class structure, and hence the long-term continuity of these habitats.

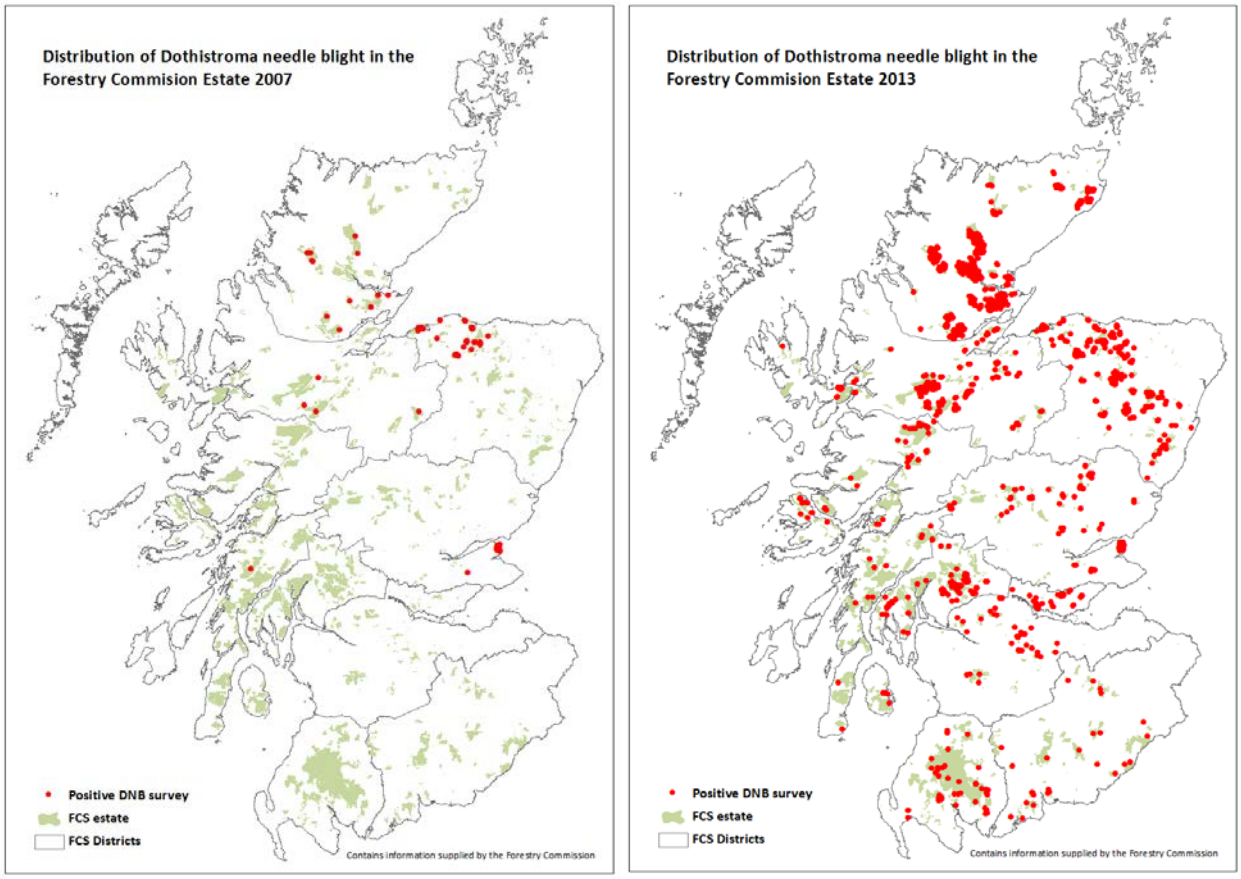
[67] Forestry Commission (2011) *Wood properties and uses of Sitka spruce in Britain. Research Report* http://www.forestry.gov.uk/pdf/FCRP015.pdf/$FILE/FCRP015.pdf

[68] ClimateXChange (2015) NF5: Diversity of Tree Species Ordered for Planting in Scotland.

[69] ClimateXChange (2015) NF7: Proportion/area of pine woodland exposed to Dothistroma needle blight (DNB). DNB has been detected in 71% of surveyed Corsican pine sub-compartments, and 26% and 21% respectively in Lodgepole pine and Scots pine sub-compartments.

[70] ClimateXChange (2015) NF7: Proportion/area of pine woodland exposed to Dothistroma needle blight (DNB). From 4,023 sites in 2007 to 24,894 sites in 2013.

Figure 2.7: Distribution of Dothistroma needle blight in the National Forest Estate, 2007 and 2013



Source: ClimateXChange indicator NF7. Contains, or is based on, information supplied by the Forestry Commission. © Crown copyright and database right 2014. All rights reserved. Ordnance Survey Licence number 100021242.

In the UK Phytophthora ramorum has, to date, primarily affected the Larch, with 41% of the species within Scottish national forest estate at the highest level of risk. Imported plants are thought to be possible source of the fungus in the UK, but it can spread through the air and via animals. Studies suggest that Pr prevails under moist, warm conditions. Since it was first detected in western Scotland in 2010, Pr has spread, most significantly in the south west. No cure has been found and there are no effective chemical treatments. Whilst the area of larch planted reduced from 200 ha in 2011 to 75 ha in 2013, the total area affected by Pr has increased since 2010, particularly in Dumfries and Galloway. There has, however, been a decrease in the number of Statutory Plant Health Notices issued for Pr (from 123 in 2012/13 to 22 in 2014/15). This could indicate a slowing in the spread of the pathogen.

Most plant non-native invasive species in Scotland have escaped from gardens. Once they become established in the wild, they are spread by soil and water movements and also on clothing and equipment. Key species include Rhododendron, Japanese knotweed, Giant Hogweed, Himalayan balsam and snowberry. There is particular concern over Rhododendron as it can harbour the Phytophthora disease organism which threatens woodlands. It is also a particular threat to the internationally important bryophyte and lichen flora of Scotland's

Atlantic oakwoods. 19% of the native woodland units surveyed in 2014 had at least one INNS present and 4% had at least three different species present.[71]

RECOMMENDATION 9: Forestry Commission Scotland should consider by the end of 2017 whether additional action is needed to reduce the spread of pests and pathogens, particularly where they threaten native Caledonian pinewoods, and whether further action to increase species diversity in the Public Forest Estate would be beneficial in order to build resilience to climate change.

2.4 Conclusions on SCCAP objectives

The table below summaries progress against the objectives listed within the SCCAP for the Natural Environment theme. For the majority of policies and proposals, the SCCAP itself did not define specific enough actions to assess whether the objectives have been achieved. The information contained within the Scottish Government's May 2015 and 2016 annual progress reports were helpful in adding clarification to the actions. The status of individual policies and proposals (as completed, on track, revised or delayed, and dropped) was self-reported by their owners in the relevant government departments and delivery agencies, and presented in the May 2016 progress report.[72]

[71] ClimateXChange (2015) NB37: Area of native woodland affected by invasive non-native plant species.

[72] The number of self-reported statuses provided was in some cases greater than the total number of SCCAP policies and proposals due to responses being received by several policy teams.

SCCAP objective	Commentary
N1-Understand the effects of climate change and their impacts on the natural environment.	There are 14 policies and proposals that support this objective. These range from broad policy measures such as the implementation of the Scottish Biodiversity Strategy, to more specific actions, such as naming research projects to be undertaken under the Scottish Marine Strategy and climate scenario modelling for tree species suitability. The majority of policies and proposals (12) were reported to be 'completed' or 'on track'. Only three were reported as being 'revised' and these were mainly to clarify the actions. Progress is being made in improving the understanding of climate change and its impacts across species and habitats in terrestrial, freshwater, marine, and coastal ecosystems. There is also ongoing research into the risks to agriculture and forestry from pests and diseases. However, there are limited efforts being taken to assess the implications of climate change for future agricultural and forestry production. Some work is taking place to disseminate the improved understanding to a wider audience including to the public.
N2-Support a healthy and diverse natural environment with capacity to adapt.	There are 23 policies and proposals that support the delivery of this objective. Of these, six were reported to be 'completed', 18 as 'on track' and two were 'revised'. They range from broad policy measures that aim to improve the overall health of ecosystems, to actions that tackle specific pressures that could be weakening adaptive capacity, such as management of deer and INNS. As noted above, adaptation principles have been embedded into the Scottish Biodiversity Strategy and clear targets have been set for improving the ecological condition of freshwater, inshore and marine environments. However more progress is needed on improving the condition of freshwater ecosystems and peatlands.
N3-Sustain and enhance the benefits, goods and services that the natural environment provides.	There are 17 policies and proposals that support this objective. Of these, three were reported to be 'completed', 15 as 'on track' and none were 'revised or delayed'. This section predominantly summarise polices that are already being implemented to support the future viability of services provided by the natural environment. Some of the action is about embedding climate change into overarching policies such as the Common Fisheries Policy and others tackle direct known impacts of climate change, such as developing containment standards for fish farms to decrease over-topping.

Chapter 3: Buildings and infrastructure networks

Key messages

Widespread flooding in the winter of 2015/16 highlighted the vulnerability of Scotland's communities and essential infrastructure to extreme weather. Almost 5% of residential properties in Scotland are at risk from river flooding and coastal inundation. In addition, new development, more impermeable surfacing, and the restricted capacity of surface water sewers, are adding to the risk of surface water and sewer flooding. Infrastructure in Scotland is also exposed to high winds, coastal erosion and cold weather. Transport routes, including for isolated and remote communities, are particularly vulnerable.

Action is being taken to reduce the vulnerability of communities to flood risk and to improve infrastructure performance during periods of extreme weather. However, there are limited data at a national scale to determine how successful these actions are in reducing risk. There is therefore a pressing need for a comprehensive review of whether current actions are sufficient to manage the risk from flooding and extreme weather, the impacts of which can otherwise be expected to increase with climate change.

This chapter assesses the progress being made with building the resilience of the built environment and infrastructure in Scotland to current and future climate change impacts.

Overview of progress

Adaptation priority	Is there a plan?	Are actions taking place?	Is progress being made in managing vulnerability?
Flooding and coastal erosion risk management	Amber	Green	Amber
Surface water and sewer flooding	Green	Green	Amber
Development in flood risk areas	Green	Red	Grey
Resilience of buildings to extreme wind and rain	Amber	Green	Amber
Water demand in the built environment	Green	Green	Amber
Design and location of new infrastructure	Green	Amber	Grey

Key messages

Resilience of infrastructure services:	 Green	 Amber	 Grey
– Energy networks - generation, transmission and distribution	 Green	 Amber	 Green
– Public water supply	 Green	 Green	 Amber
– Ports, airports and ferry services	 Amber	 Amber	 Grey
– Roads and the rail network	 Amber	 Green	 Green
– Digital infrastructure	 Amber	 Grey	 Grey
Infrastructure interdependencies	 Green	 Amber	 Grey

Summary of progress

Policies and programmes are in place to manage river, coastal, sewer and surface water flood risk, and adapt coastal areas to continuing erosion. Operators across most infrastructure sectors are taking steps to improve the performance of their networks during periods of extreme weather:

- **Efforts are being made to manage flood risk from rivers and the sea.** Legislation requires mandatory flood risk management strategies at the national and local levels and for these to be updated every six years. Each strategy has a target of a net reduction or zero net increase in expected flood damages and the number of properties at risk. The Scottish Environment Protection Agency (SEPA) will report on progress against these targets twice within each six-year cycle. Capital investment in flood defences has been increasing, on average, by 16% per year since 2010. About 8,500 properties have benefitted from new or refurbished flood defence structures since 2005. Further capital investment is due to be delivered from 2016-2021 that, if fully implemented, will reduce flood risk for an additional 10,000 properties. A national system of flood warnings has been in place since 2011 and is used by the majority of local authorities.
- **Strategic approaches to planning for long-term coastal change are being taken in some areas.** Shoreline Management Plans have been developed for some of the most vulnerable stretches of the coastline. A National Coastal Change Assessment is also

Key messages

underway. This will develop the evidence base to inform further strategic management for other stretches of the Scottish coastline.

- **Regulations are in place that requires sustainable drainage systems (SuDS) in some new development, and investments have been made to reduce surface water and sewer flood risk.** The use of SuDS is well established, although with the primary objective of improving water quality and only partly to reduce surface water flooding. Local authorities have a legal duty to manage surface water flood risk, and Scottish Water has allocated £168 million to be spent between 2015 and 2021 to reduce risk from sewer flooding.
- **National policy requires local authorities to take current and future flood risk into account when preparing development plans and determining planning applications.** Planning authorities should aim to prevent development that would have either a significant probability of being affected by flooding, or increase the probability of flooding elsewhere. Very few applications are granted contrary to the advice of SEPA. Building Regulations include standards related to flood resilience and moisture penetration from heavy rain.
- **A strategic framework to improve the resilience of Scotland's critical national infrastructure is in place.** This aims to support operators in both the public and private sectors to build the resilience of their services, including to present-day risks from flooding and extreme weather.
- **Electricity transmission and distribution companies are taking a comprehensive approach to increasing resilience.** Risks from flooding and storms are being consistently assessed through industry-wide standards and there is transparent reporting to the regulator on the progress being made with resilience measures. Considerable funding has been, or is due to be, invested in better protecting electricity sub-stations against the risk of flooding.
- **Scottish Water is investing to improve the resilience of water supplies both in terms of network performance and in terms of water resource management.** Scottish Water plans to spend £55 million between 2015 and 2021 and investigate how best it can extend its network to increase resilience. 12 separate projects were undertaken between 2010 and 2015 to understand the impacts of climate change on Scottish Water's ability in future to provide secure and reliable water supplies.
- **Progress is being made with reducing water leakage rates.** Between 2006/07 and 2014/15 leakage rates fell from 44% to 33% of the public water supply. However, leakage rates in Scotland remain higher than estimates for other European countries.
- **Progress is being made in assessing climate change risks to road and rail networks.** Both sectors have carried out climate change risk assessments and have weather resilience and climate change plans in place. Investments are being made to renew critical assets and structures, such as bridges, tunnels, coastal defences and embankments.

Key messages

However, there are areas where a lack of data makes it difficult to assess progress. There are also some trends that suggest the vulnerability to climate change impacts may be increasing.

- **There has been no long-term assessment of flood risk management investment needs.** Nearly 90% of at risk properties are not protected by flood defences. The Scottish Government has not assessed whether current plans are consistent with being able to manage long-term flood risk in the context of climate change. Even if current plans are fully implemented, 58,000 properties are projected to have at least 1-in-200 annual chance of being flooded in the 2030s.
- **Uptake of property-level resilience measures appears to be low.** By 2014, only nine of the 32 local authorities in Scotland had implemented schemes to promote the uptake of property-level flood protection, and there is no data available on actual uptake. The number of properties affected by damp and condensation has not reduced despite efforts over the last decade.
- **Vulnerability to surface water and sewer flood risk could be increasing.** The area of impermeable surfaces in urban areas is steadily increasing, primarily due to new car parks, and front gardens being paved over. These trends in urban creep are likely to be increasing the risk of surface water and sewer flooding, especially when combined with limited sewer capacity in many locations and the heavier rainfall events projected with climate change. Sales of permeable paving remain low and SuDS are only mandatory where developments discharge directly to watercourses. Data on the actual uptake of SuDS in new development are not collected.
- **National planning policy on flood risk is not being consistently applied by local authorities.** Not all local authorities have undertaken a Strategic Flood Risk Assessment to inform Local Development Plans, and it is not clear that a precautionary approach to flood risk is taken in practice, as is required by planning policy. There is evidence that site-specific Flood Risk Assessments are not always conducted when they should, and SEPA is not necessarily consulted on applications in flood risk areas.
- **Little progress is being made in reducing the demand for water, despite the potential risk of water scarcity in some parts of Scotland in the future.** Building Regulations have included water efficiency standards in new development since 2014, and Scottish Water has a water efficiency plan. However the overall consumption of water per person is still high even though it has decreased over recent years. More needs to be done to consider supply/demand measures in the context of future climate projections.
- **A number of important strategic plans for Scotland's infrastructure do not explicitly consider the need to build resilience to the future climate.** The Infrastructure Investment Plan 2015, which sets out priorities for investment and development of public infrastructure in Scotland up to 2035, does not make any reference to future resilience. Similarly, Scotland's Digital Future (2013) fails to mention climate change impacts. It is also not clear whether new infrastructure is being designed to account for current and future climate risks.

Key messages

- **A lack of data means it is difficult to assess whether infrastructure is now performing better or worse in severe weather than in the past.** In December 2015 and January 2016, 15 drinking water systems and over 100 waste water systems were affected by flooding. Supply interruptions due to extreme weather are not reported separately to other supply interruptions.

Recommendations for further progress

These recommendations predominantly focus on the need to monitor and report actions taking place and to track whether these are reducing long-term vulnerabilities.

RECOMMENDATION 10: The Scottish Government should assess the level of flood risk management interventions and investments that are likely to be needed to reduce risks in each part of Scotland to acceptable levels over the next 25 to 50 years, accounting for the impacts of climate change and sea level rise. This assessment should help ensure that the objectives set in the next Flood Risk Management Strategies, due in 2021, are compatible with reducing flood risk in the long term.

RECOMMENDATION 11: The Scottish Environment Protection Agency should ensure the next Flood Risk Management Strategies monitor and report:

1) The impact of local flood risk management plans in reducing surface water flood risk, including in relation to managing urban creep.

2) The number and capacity of SuDS installed in new developments and of other drainage assets retrofitted with SuDS.

3) The number of planning applications for new developments in the floodplain that were granted, and within these, the number of applications for which SEPA advice was sought and the number of applications to which SEPA objected.

4) The number and location of new homes and other properties built in areas of flood risk.

RECOMMENDATION 12: The Scottish Government should review before the next SCCAP whether further action is required to deliver and sustain reductions in average water consumption per person in Scotland. As part of this review, Scottish Water should publish the outputs of their water efficiency trials, including an assessment of the impact of metering.

RECOMMENDATION 13: The Scottish Government should work with all infrastructure sectors before the next SCCAP to develop consistent incident reporting, together with indicators of network resilience and performance, and the implementation of resilience measures, to allow improvements in resilience to extreme weather events to be measured over time.

3.1 Risks to, and opportunities for, Scotland's buildings and infrastructure networks from climate change

The built environment consists of man-made domestic and non-domestic buildings where people live and work and the infrastructure assets and networks that provide essential services. Climate change will impact the built environment via direct and immediate damage caused by extreme weather including flooding, as well as via longer-term impacts from changes in

seasonal temperatures and precipitation. These will for example affect moisture levels in the fabric of buildings and the soils they are built upon.

The built environment is characterised by long-lived assets involving significant capital expenditure. Decisions on the design and location of new buildings and infrastructure can greatly influence their whole-life costs. Climate change can affect such costs, and where explicitly considered during the design phase, could lead to different choices being made. Proper evaluation of climate risks means that decisions can be made as to whether the upfront costs of precautionary design standards are justifiable in order to safeguard long-term asset values. An alternative is to design assets with the option to upgrade should climate or other design thresholds be exceeded (termed a 'managed adaptive' approach). Whilst over-specification can waste resources, in general retrofitting long-lived assets will be more expensive than incorporating higher standards from the outset.

The built environment in Scotland includes:

- 2.43 million homes[73] including 310,000 traditional buildings built before 1919, and 370,000 post-war terraced houses built before changes in standards in 1982.[74]
- 47,000 listed buildings of special architectural or historic interest.[75]
- 55,961km of road network including 6% trunk roads, 13% A roads and 81% minor roads.[76]
- 2,763km of rail network and 351 stations, with 86.3million ScotRail passengers in 2013/14.[77]
- Energy infrastructure both onshore and offshore (38%), with around 33% nuclear electricity generations, 5% gas, 2% oil.[78]
- 18 airports, four of which (Aberdeen, Edinburgh, Glasgow and Glasgow Prestwick) account for 94% of total passengers. There are 13 other airports mainly serving the islands.[79]
- 110 ports, nine of which are classed as major. In 2013 Scottish ports handed 72 million tonnes of freight and the ferry services carried 7.8 million passengers, with 2.6 million of those being within Scotland.[80]

The SCCAP dedicates a chapter to the policies and programmes in Scotland that address the climate risks to buildings and infrastructure. The policies and proposals for infrastructure predominantly focus on the road and rail networks. Risks to other essential services such ferry services and offshore energy infrastructure are not covered in detail.

Whilst it is acknowledged that policies for some of Scotland's infrastructure are the responsibility of Whitehall departments (as UK-wide reserved matters) there may be specific assets or adaptation challenges in Scotland worthy of further consideration. At the very least, the inter-

[73] National Records of Scotland (2015) *Estimates of Households and Dwellings in Scotland, 2015*. http://www.nrscotland.gov.uk/files//statistics/household-estimates/house-est-15/15house-est.pdf
[74] Scottish Government (2014) *Scottish House Condition Survey: Key findings.* http://www.gov.scot/Resource/0049/00490947.pdf
[75] Historic Environment Scotland. https://www.historicenvironment.scot/advice-and-support/your-property/owning-a-traditional-property/living-in-a-listed-building/
[76] Transport Scotland (2014) http://www.transport.gov.scot/statistics/j357783-07.htm
[77] Transport Scotland (2014) http://www.transport.gov.scot/statistics/j357783-10.htm
[78] DECC Energy Trends Dec. (2016), In 2014 coal made up 14%.
[79] Transport Scotland (2014) http://www.transport.gov.scot/statistics/j357783-11.htm
[80] Transport Scotland (2014) http://www.transport.gov.scot/statistics/j357783-12.htm

dependencies between infrastructure risks and other impacts such as for businesses and communities should be explored.

The first CCRA, published in 2012, identified a number of the risks and opportunities to the built environment in Scotland, including:

- **Flooding.** Though CCRA1 had limited data on flood risk in Scotland, increased flooding from a combination of sources (rivers, sea, and sewers) was projected. More recent data from SEPA and the second CCRA (CCRA2) suggests 10,000 more homes will have at least 1-in-75 annual chance of flooding by the 2050s, and 18,000 more by the 2080s assuming a two degree rise in global temperatures and current approaches to adaptation continue.[81]
- **Vulnerability of building fabric.** Buildings are also likely to be at increasing risk of damage from storms, wind and driving rain with increased condensation and water penetration into masonry. The 47,000 listed historic buildings in Scotland are particularly susceptible.[82]
- **Infrastructure disruptions due to extreme weather events.** There is a projected increase in disruption to transport links due to flooding and landslides caused by heavy rainfall and stormy weather. CCRA1 estimated that 10-20% of roads and railways in Scotland are at a significant likelihood of flooding.[83] Scotland has infrastructure in exposed coastal locations, as well as remote and isolated communities reliant on ferry services as well as roads for transportation.
- **Overheating of buildings.** Higher temperatures are expected to decrease energy demand for heating in winter but increase energy demand for cooling in summer. Household energy consumption is projected to reduce by up to 6,000GWh/yr (50%) for East Scotland, 3,000GWh/yr (60%) for North Scotland and 8,000GWh/yr (60%) for West Scotland by the 2080s, under a high emissions p90 scenario, assuming no change in population. Higher temperatures will also increase the risk of homes and other buildings overheating, particularly in urban areas. The urban heat island effect moderates cold temperatures in winter but accentuates highs in summer, with the effectiveness of green spaces in regulating air temperatures diminishing in hot, dry weather. Higher temperatures were also projected to reduce water availability in summer in some parts of Scotland potentially affecting both domestic and non-domestic users.
- **Opportunities from new trade routes.** Ports will be exposed to rising sea levels but could benefit from the opening up of Arctic sea routes. The Northeast Passage is projected to be open for 120 days per year by the 2050s.

In July 2016, the ASC published an Evidence Report to inform CCRA2. The Evidence Report includes a national summary for Scotland, which covered the above risks from CCRA1 but also highlighted some new evidence that has become available. This includes projections of river, coastal, surface water and groundwater flooding for Scotland (not just England and Wales as in CCRA1) and risks to coastal communities from sea level rise beyond 1 metre. CCRA2 also provided new insights into risks resulting from infrastructure interdependencies.

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81 Sayers, P. B. et al. (2015) *Climate Change Risk Assessment 2017: Projections of future flood risk in the UK.* https://www.theccc.org.uk/publication/sayers-for-the-asc-projections-of-future-flood-risk-in-the-uk/

82 Historic Environment Scotland (2015) *Scotland's Listed Buildings.* https://www.historicenvironment.scot/media/2248/scotlandslistedbuildings.pdf

83 Significant likelihood of flooding is defined here as' an annual probability of any form of flooding of 1 in 75 or greater'.

3.2 SCCAP objectives for buildings and infrastructure networks

The SCCAP contains a high level outcome for this theme: "A Scotland with well-managed, resilient infrastructure and buildings providing access to the amenities and services we need." There are three objectives to meet this outcome:

- **Objective B1**: Understand the effects of climate change and their impacts on buildings and infrastructure networks.
- **Objective B2**: Provide the knowledge, skills and tools to manage climate change impacts on buildings and infrastructure.
- **Objective B3**: Increase the resilience of buildings and infrastructure networks to sustain and enhance the benefits and services provided.

The SCCAP objectives describe important high-level principles and processes for adaptation in the built environment. However, as noted in Chapter 1, the SCCAP objectives tend to describe processes rather than outcomes and do not state goals against which substantive progress can be measured. Even where stated objectives are being achieved, vulnerability to climate change impacts may be increasing.

To enable a robust assessment, the ASC has identified a set of adaptation priorities for each of the SCCAP themes. The progress being made in respect of each of these adaptation priorities is reviewed in Section 3.3. Progress with each of the three objectives is also summarised in Section 3.4.

Figure 3.1 presents the climate hazards, contextual factors and adaptation priorities that are relevant to the built environment, together with a summary of the relevant policies and proposals listed in the SCCAP.

Figure 3.1: Climate hazards, contextual factors and adaptation priorities for buildings and infrastructure

Climate hazards	Contextual factors	Adaptation priorities	Summary of relevant SCCAP policies and proposals
Warmer, drier summers Reduced water availability Increased winter rainfall More heavy rainfall days Sea level changes	Population growth Other demographic changes Economic growth Leaving the EU	Flooding and coastal erosion risk management	• Development of flood risk management strategies and plans • Integrated approach to catchment modelling • Implement and monitor National Marine Plan
		Surface water and sewer flooding	• River basin management plans • Continue work of the SuDs working party • Consider long term approach to managing sewer systems • Research into benefits of PLP and developing to guidance for LAs
		Development in flood risk areas	• Planning Advice note on flooding, water and drainage for applicants and LAs
		Resilience of buildings to extreme wind and rain	• Research to identify resilience measures for new and existing buildings and historic buildings • Implement Historic Scotland's Climate Change Action Plan • Building Regulations Guidance on best practices to adapt to climate change • Promote sustainability in architecture programme • Improve housing quality and energy efficiency
		Water demand in the built environment	• New building standards for water efficiency provision in dwellings • Scottish Water's investment programme including to manage leakage across the network
		Design and location of new infrastructure	• Implement Scottish Planning Policy • Scottish capital investment manual guidance • Introduce guidance on supporting infrastructure
		Resilience of infrastructure services: • Energy • Public water supply • Ports, airports and ferry services • Rail and trunk roads • Digital Infrastructure	• Implement Critical National Infrastructure strategy for Scotland and National Transport Strategy (2006) • Undertake resilience risk assessments across each infrastructure sector • Trunk Road survey on perceptions of disruption by severe weather • Research into fog projections and landslide-prone road networks • Work with forest estate to increase slope stability • A central co-ordination point for information and data collection within the Road Asset Management Plan • Develop and implement flood risk management strategies and plans • Promote joint working between energy generators • Develop high winds strategy • Incorporate weather events into road maintenance contracts • Tomorrow's Railway and Climate Change adaptation programme • National and regional planning frameworks implemented in ports
		Infrastructure interdependencies	• Promote 'keep Scotland running' guidance for critical infrastructure resilience

3.3 Progress being made

This section evaluates the extent to which the actions and policies in the SCCAP and elsewhere are addressing the identified climate risks, following the method outlined in Chapter 1. Further details and the underlying evidence supporting the analysis of each of the adaptation priorities can be found in Annex B, available on the CCC's website.

3.3.1 Flooding and coastal erosion risk management

Is there a plan?	 Amber	Flood Risk Management Strategies are in place that set the strategic direction for managing flood risk in the 243 Potentially Vulnerable Areas across Scotland. Flood Risk Management Plans were published in 2016 that set out actions, including new flood defences, natural flood risk management and encouraging property level protection (PLP). The FRMS and FRMPs are developed, implemented and updated on a six-year cycle. There is no national assessment to quantify whether the actions identified in the strategies are sufficient to avoid flood risk increasing, or to identify flood risk management interventions and investments that are likely to be needed to reduce risks to acceptable levels over the next 25 to 50 years. Flood Re, the new UK-wide subsidised flood insurance scheme, provides time-limited support to high risk households but removes the financial incentive to take action to protect homes against flooding.
Are actions taking place?	 Green	Capital expenditure from all sources in flood risk management has increased from £42 million in 2012-13 to £78 million in 2014-15. Around one-third of local authorities implemented schemes to help high risk households to purchase property-level flood protection products, although the actual uptake remains low. SEPA flood warning schemes are now available in half of Potentially Vulnerable Areas, with plans to extend this to more than 60% of areas in coming years.
Is progress being made in managing vulnerability?	 Amber	There has been a steady increase in the number of properties protected by new or enhanced flood defences since the mid-2000s, and a further 36,000 properties (27% of the properties currently at any degree of flood risk) might benefit from flood risk reduction measures by 2027. However, by the 2030s, there are still likely to be 58,000 properties with at least a 1 in 200 annual chance of being flooded. This, alongside the low uptake of property-level flood protection, suggests that there is still likely to be a high level of residual risk in the future.

About one in 22 residential properties and one in 13 businesses in Scotland are at risk of river, coastal and/or surface water flooding.[84] In December 2015, two major flood events affected

[84] SEPA (2015) *Flood risk management in Scotland: Working together to deliver.* https://www.sepa.org.uk/media/162585/frm_work_together_leaflet.pdf

large areas of the country. Between the 4th and the 6th December, Storm Desmond caused widespread damage from Speyside to the Borders and Dumfries and Galloway through Tayside, Central, Stirlingshire and the Clyde Valley. An estimated 150 properties were flooded, people were evacuated, roads were closed and extensive areas of farmland inundated.[85] Although the return period of these events is not yet clear, the levels of the Garry, Teviot and Upper Spey rivers were the highest ever recorded in their 25, 55 and 63 year records. On 30th December 2015, Storm Eva caused widespread flooding from Dumfries and Galloway in the west to Speyside and Tweedside in the east. This flooding followed intense rainfall concentrated in a 12 hour period. In Galloway 112mm of rain fell in 12 hrs, which is approximately a 1-in-120 year event. Many river flows were at highest ever recorded levels.

An estimated 12% of the Scottish coastline is experiencing erosion.[86] There have been a number of recent examples of erosion events affecting Scottish beaches.[87]

Is there a plan?

Strategies, action plans, indicators and monitoring frameworks are in place to deliver a reduction in flood risk over the next six years. There is, however, no longer term (25-50 year) plan in place to adapt to changing flood risk.

Flood risk management in Scotland is the responsibility of the Scottish Government, Local Authorities, SEPA and Scottish Water.[88] The Scottish Government is responsible for the overall strategy and contributes funding to flood risk management schemes. SEPA is the strategic flood risk management authority and has the responsibility to develop Flood Risk Management Strategies (FRMS), which outline the overall principles and six-year objectives for managing flood risk. SEPA also provides a National Flood Risk Assessment, undertakes flood risk mapping and is responsible for implementing flood warnings. However, this national flood risk assessment does not take in to account the potential impacts of climate change nor other factors that might decrease or increase the risk, such as new properties built in the flood plain or new flood risk management measures. This means it is not known how flood risk could change in the long term and whether proposed adaptation actions and potential long-term investments will be sufficient to reduce risks to acceptable levels.

Local authorities are required to develop Flood Risk Management Plans (FRMP) to deliver the local FRMS, including implementing flood protection schemes and surface water flood risk management measures. Scottish Water is responsible for managing the risks from sewer flooding (discussed in section 3.3.2 below).

In December 2015, SEPA published the first FRMS's that split Scotland into14 strategic areas.[89] Each FRMS lays out the strategic direction for flood risk management focusing on the measures needed to reduce risk in the 243 Potentially Vulnerable Areas (PVAs) identified by SEPA's national flood risk mapping. The PVAs are catchments where flood risk is considered to be

[85] Ibid.

[86] http://www.crew.ac.uk/sites/www.crew.ac.uk/files/publications/coastal_flooding_in_scotland.pdf

[87] Examples of coastal erosion highlighted by the National Coastal Change Assessment have been seen in the last 2 years include: Melby Beach (Shetland), beaches on Sanday (Orkney), and numerous examples in Western Isles.

[88] http://www.jbaconsulting.com/blog/what-are-drivers-flood-risk-management-frm-scotland

[89] The 14 areas are described by SEPA as Local Plan Districts, although they are sub-national in extent and mostly comprise more than one local authority area. Some examples include the Forth Estuary, Solway, Highland and Argyll and the Outer Hebrides.

'nationally significant' and are estimated to contain 92% of the total number of properties at flood risk in Scotland.

Corresponding local FRMP's were published in June 2016 by lead local authorities responsible for flooding, in partnership with the other councils in each of the 14 Local Plan Districts. The FRMPs include details on specific actions and implementation timelines to deliver the FRMSs.[90] SEPA is required to collate data from local authorities and report on progress with the implementation of the FRMPs between the second and the third year after publication, and six years after publication of the FRMSs. The first round of reporting on the FRMPs is due by 2019, with the final report due in 2021.

The FRMS include plans for 42 formal flood protection schemes to start between 2016 and 2021. The estimated cost of these works in the six year cycle is £235 million, but with potential wider benefits amounting to £1.3 billion. Delivery of these works would reduce flood risk to around 10,000 properties, with standards of protection ranging between 1-in-200 and 1-in-50.[91]

SEPA and local authorities have established a programme of mapping and modelling to target priority areas where understanding of flooding can be improved. Flood protection studies are set to be taken forward between 2016 and 2021 to further define the underlying flood risk problems and identify appropriate actions. There are over 130 studies planned by local authorities and others, aiming to identify potential measures for around 26,000 residential properties currently at risk.

The overall objective of the strategies is to either reduce flood risk or to achieve a zero-net-increase of flood risk. However, for the PVAs in which flood risk reduction is proposed, no targets are set in terms of standards of protection. It is not clear whether the actions listed in the plans are in line with achieving a zero-net increase in the longer term.

Flood Re, the new UK-wide subsidised flood insurance scheme, is funded by a new £180 million tax on home insurance. This is due to provide time-limited support to high risk households by keeping their insurance costs artificially low. However, by doing so Flood Re removes the financial incentive for high risk households to take action to protect themselves against flooding. Flood Re is required under the Water Act 2014 to wind up its operations within 25 years of the Act being passed, and during that period to gradually withdraw subsidies so that risk-reflective pricing emerges in flood risk. As part of Flood Re's transition plan, there are proposals to encourage households to better protect their properties so that the chance of needing to make a claim is reduced. The aim is to allow insurance to remain available and affordable without the need for ongoing subsidies.

Under the Coast Protection Act 1949 local authorities are responsible for both coastal 'protection' and 'prevention'. To date, eight Shoreline Management Plans have been developed across Scotland. The actions laid out in the FRMPs in some places also cover coastal erosion. A National Coastal Change Assessment is underway that should inform existing strategic planning, but will also identify those areas which may require supplementary support and planning.

[90] SEPA (2015) *Natural Flood Management Handbook*. http://www.sepa.org.uk/media/163560/sepa-natural-flood-management-handbook1.pdf

[91] https://www.sepa.org.uk/media/163528/42-flood-protection-schemes.pdf

Are actions taking place?

Considerable funding has been made available for flood defence projects. Actions are taking place to inform the public of the risks to which they are exposed. However, it is not clear how many households are installing measures to protect their properties from flooding.

Scottish Government has allocated £42 million of capital funding for flood defences per year between 2011 and 2016, and has agreed with the Convention of Scottish Local Authorities (COSLA) to continue this funding until 2027. Further expenditure has been allocated following major flood events or at discretion of individual Local Authority. For example, in 2014 the Scottish Government made available an additional £38.5m to cover 80% of the total cost of two major new flood defence schemes[92] and contributed £0.5 million towards the cost of repairing damage caused by severe flooding in Dumfries and Galloway. Capital expenditure on flood defence from all government sources has been increasing, from about £43 million in 2012-2013 to over £78 million in 2014-15.[93]

Revenue expenditure on flood defences (i.e. maintenance) has slightly declined, from just below £12 million in 2012-2013 to £10 million in 2014-2015. However, investment is still well above the 2010 level (less than £8 million), possibly reflecting the substantive increase in flood defence assets created over the last decade.

As well as formal flood protection schemes, actions are being taken to reduce the impact of flooding when it does occur. These include the development of flood warning systems and the promotion of measures that can be taken by householders.

SEPA delivers 'floodline', a flood warning service for members of the public as well as a flood forecasting service for local authorities and emergency responders. Flood warning schemes are currently in place for 50% of the 243 PVAs. SEPA plans to deliver 14 new schemes by 2021, which if implemented will result in over 60% of Potentially Vulnerable Areas being covered.[94]

Scottish Government encourages local authorities to set up schemes that provide free flood risk surveys and subsidise property-level protection to households at highest flood risk. To date, 28% of local authorities have implemented such schemes.[95] The FRMSs include plans for four new schemes. Research for Scottish Government concluded that approximately 43,000 properties could benefit from PLP at present, and a further 13,000 could benefit by 2035.[96]

Actions have also taken place to encourage and improve the capability of communities to prepare and respond to floods. The Scottish Flood Forum supports the development of community flood resilience groups, which take action on specific residence issues and improve flood risk awareness in schools. There are currently 61 Scottish Community flood resilience groups in operation across Scotland.

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92 http://www.waterbriefing.org/home/flooding/item/8949-scottish-govt-awards-%C2%A340million-extra-flood-defence-funding

93 Scottish Government Local Financial Statistics on capital expenditure on flood protection (2012-2015) http://www.gov.scot/Topics/Statistics/Browse/Local-Government-Finance/PubScottishLGFStats

94 Communication with SEPA.

95 JBA (2014a) *Assessing the Flood Risk Management Benefits of Property Level Protection*.

96 Ibid.

Heritage buildings require different methods of protection. The INFORM publications provide quick start guidance to protect heritage buildings from flood damage to specific wood features and plaster, and to put in place permanent flood resilient features that are not intrusive.[97]

Is progress being made in managing vulnerability?

The number of properties protected against flooding has increased from about 4,500 in 2005 to about 13,000 in 2015.

According to SEPA's National Flood Risk Assessment, an estimated 134,000 residential properties are located in areas with a 1-in-1000 annual chance of flooding or greater, of which about 80,000 residential properties have at least 1-in-200 chance of being flooded during any one year.[98]

The number of properties protected by flood defences has increased from about 4,500 in 2005 to 13,000 in 2015.[99] This equates to 10% of the estimated total number of properties currently at risk of flooding and 16% of properties currently at a 1-in-200 annual chance. The FRMSs have collectively set a target of a further 10,000 properties being protected by 2021. These schemes will provide standards of protection ranging from 1 in 200 to 1 in 50.[100] Research is ongoing to assess options to reduce flood risk to a further 26,000 properties by 2027. It is not known what standard of protection will be achieved for these 26,000 properties. Figure 3.2 shows the current, planned and projected number of properties with at least 1-in-200 annual chance of flooding.

It is clear that some progress has been made in increasing the number of properties protected and that risks will be further reduced if planned measures up to 2027 are implemented. However, there will still be around 58,000 properties with at least 1-in-200 annual chance of flooding in the late 2020s, even if planned measures are fully delivered. Some of these properties might have a significantly higher annual chance of flooding than 1-in-200. However, it is not possible to assess current and future levels of residual risk with the available data.

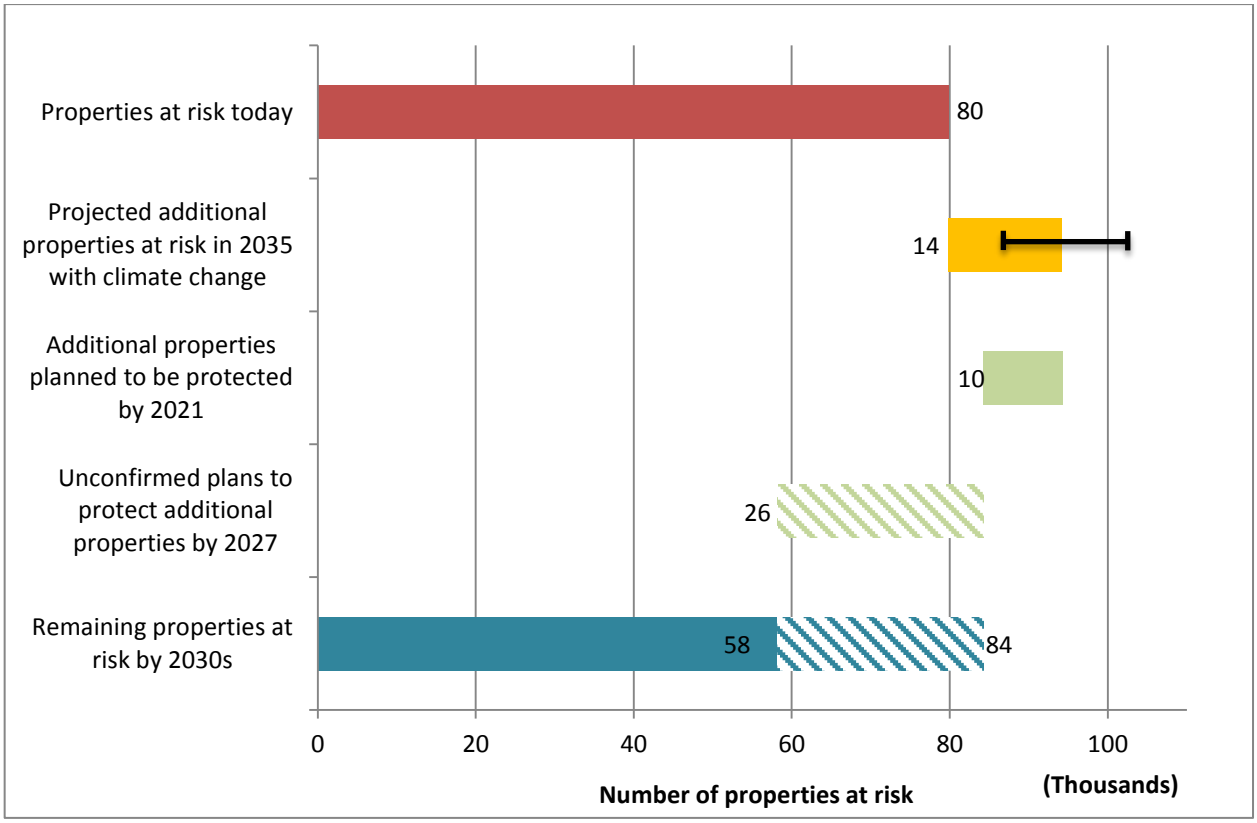
97 http://conservation.historic-scotland.gov.uk/home/publications.htm?callback=1&searchterm=&system.customproperties.pt5=on&submit=Search

98 SEPA Flood Risk Management Strategies.

99 JBA (2014b) *Assessing the Flood Risk Management Benefits of Property Level, Technical Report*; JBA (2007) Scottish Flood Defence Asset Database; Communication with JBA.

100 https://www.sepa.org.uk/media/163528/42-flood-protection-schemes.pdf

Figure 3.2: Current and projected estimates of properties at flood risk



Sources: SEPA Flood Risk Management Strategies (number of properties at risk today), communication with SEPA (properties planned to be protected by 2012 and 2026) and JBA (2014b)[101] (percentage increase of number of properties at risk in 2035).
Note: SEPA estimates that about 80,000 residential properties are currently in areas with a 1-in-200 annual chance of flooding (red bar). Under plans within the FRMSs, flood risks would be reduced for a further 10,000 properties by 2021 (green bar). Research is ongoing to assess options to protect 26,000 further properties by 2027 (dashed bar). Due to climate change, 14,000 further properties might be located in areas at flood risk by 2035 (orange bar). This suggests that 58,000 properties would still have at least 1-in-200 annual chance of flooding in 2030s.

There appears to be limited progress with the uptake of property-level protection, although actual numbers of installations are not monitored nationally. A 2014 survey reported that less than half of households surveyed had PLP in place, despite all these households being located in high flood risk areas.

There has been an increase in the uptake of flood warnings. In March 2014 there were 18,500 registered users of SEPA's Floodline, an increase of 16% from the previous year. The uptake of the SEPA's flood forecasting service among Category 1 and Category 2 Responders increased by 46% between 2012 and 2014.[102] In 2014, 78% local authorities reported using SEPA and/or local authority flood warnings.[103]

[101] JBA (2014b) *Assessing the Flood Risk Management Benefits of Property Level*, Technical Report.
[102] ClimateXChange (2015) CRS20: Number of flood incidences attended by SFRS.
[103] JBA (2014a) Assessing the Flood Risk Management Benefits of Property Level Protection.

RECOMMENDATION 10: The Scottish Government should assess the level of flood risk management interventions and investments that are likely to be needed to reduce risks in each part of Scotland to acceptable levels over the next 25 to 50 years, accounting for the impacts of climate change and sea level rise. This assessment should help ensure that the objectives set in the next Flood Risk Management Strategies, due in 2021, are compatible with reducing flood risk in the long term.

3.3.2 Surface water and sewer flooding

Is there a plan?	 Green	Surface Water Management plans are being developed for 103 of the 243 Potentially Vulnerable Areas identified as being at highest risk from surface water flooding. Sustainable Drainage Systems (SuDS) are a requirement in new development where surface water flows directly into the water environment. Scottish Planning Policy (2014) requires the avoidance of increased surface water flooding through requirements for SuDS and minimising the area of impermeable surface. Just over half (53%) of a sample of planning applications stated that surface water would be managed using some form of SuDS scheme.
Are actions taking place?	 Green	SEPA has piloted surface water flood forecasting, produced surface water flood maps and identified 103 Potentially Vulnerable Areas for which Surface Water Management Plans are being developed. Between 2010 and 2016, Scottish Water invested £28 million to reduce sewer flood risk and £14 million to develop catchment-scale models to inform future strategic investment planning. Scottish Water plans to invest a further over £168 million to reduce sewer flooding risk between 2015 and 2021. The Metropolitan Glasgow Strategic Drainage Partnership has delivered five major projects to reduce surface water flood risk, valued at about £100 million. A further £250 million is due to be invested between 2013 and 2018.

Is progress being made in managing vulnerability?	 Amber	Surface flood risk has been reduced for about 7,000 properties in Metropolitan Glasgow, and the number of flooding incidents from main sewers has decreased by 17% since 2010. Despite this progress, there are still over 9,000 properties with at least 1-in-200 chance of surface water flooding located within the Potential Vulnerable Areas around Glasgow City.[104] Over 300 residential properties have at least 1-in-10 annual chance of being flooded from sewers. There is no up to date register or monitoring of SuDSs installed in new or existing developments. The area covered by impermeable surfaces is increasing across all local authorities, potentially contributing to increase surface water flood risk in some locations, although the increase has been relatively low in many built-up areas.

Is there a plan?

There are clear policies in place to manage local flood risk from surface water and sewers, and surface water management plans are being developed. Policies include requirements for the use of SuDS in new development.

The Flood Risk Management (Scotland) Act 2009 requires all 'responsible authorities' (i.e. local authorities, SEPA, Scottish Water and Scottish Government) to co-operate to develop Surface Water Management Plans. The Flood Risk Management Strategies published in 2015 commit to developing Surface Water Management Plans for nearly half of Potential Vulnerable Areas by 2021.[105]

Scottish Water is responsible for the management of Scotland's public sewerage system. The investments that Scottish Water is required to make are set out by Scottish Ministers. For the investment period 2015-2021, Scottish Water is planning to invest £6 million in flood resilience assessments and £1.7 million in surface water management investigations. These studies will inform the appraisal of measures to improve the management of surface water flooding.

Scottish Water is responsible for protecting properties from flooding caused by sewers being blocked or overwhelmed by rainfall events within the network's maximum design criteria (1:30). [106] For the investment period 2015-2021, Scottish Water plans to invest £112million in capital works to reduce risks to residential properties with a 1-in-10 annual chance of flooding from sewers, and an additional £49million to reduce flood risk to non-residential properties and land. Scottish Water is also working to separate surface water and foul water sewers, along with the disconnection of legacy surface water connections to its combined sewers. The latest guidance to developers to help deliver this plan is laid out in Sewers for Scotland (3rd Edition).[107]

[104] Clyde and Loch Lomond Flood Risk Management Strategy, SEPA
[105] 103 PVAs of the 243 in Scotland.
[106] http://www.scottishwater.co.uk/business/connections/connecting-your-property/sewers-for-scotland-and-suds
[107] Ibid.

Scottish Water is part of the Metropolitan Glasgow Strategic Drainage Partnership (MGSDP, see Box 3.1). As part of its 2013-2018 investment plan, the MGSP will invest £250million to reduce surface water flood risk and improve water quality within Metropolitan Glasgow. One of the objectives of the MGSDP is to support planning authorities' preparation of new local and strategic planning policies, including promoting the use of SuDS.[108]

Requirements for the use of Sustainable Drainage Systems (SuDS) feature in national planning policy and associated regulations:

- **Scottish Planning Policy (2014)** requires that the area of impermeable surface should be kept to a minimum in all new developments and promotes the avoidance of increased surface water flooding through SuDS. Drainage Assessments, covering both surface and foul water, are required for new developments in areas where drainage is already constrained, or where there would be off-site effects. This policy also requires planning authorities to carry out a comprehensive assessment of green spaces, and to ensure that the Local Development Plans include provisions for maintaining or improving multi-functional green spaces.
- **National Planning Framework 3 (NPFs)** sets a strategy and priorities for development in Scotland for the next 20-30 years, but does not explicitly reference SuDS. However, the NPF3 designates the MGSDP as a national development.
- **Water Environment (Controlled Activities) (Scotland) Regulations 2011** includes a general requirement for SuDS to be installed where new developments have surface water that flows into the water environment. Exceptions are made for single dwellings and where the discharge is directly to coastal waters.[109] The separation of foul from surface water is a standard requirement for all new developments where this can be achieved.
- **Permitted development rights** extend only to porous materials or where runoff is directed to a porous area within the curtilage of a dwelling. The use of hard surfaces between a dwelling and a road therefore requires planning permission. This provision was introduced to mitigate the cumulative impact of small increases in hard surfacing leading to increased run off into road drains that ultimately flow into watercourses or sewage treatment works.

Are actions taking place?

Actions are in place to update existing guidelines and improve the understanding of the risk. Investments have been made to reduce the risk of surface water flooding in Glasgow and to better protect properties from sewer flooding.

The main action in the SCCAP relating to surface water flooding is to promote the uptake of SuDS, predominantly through the SuDS Working Party established in 1997. The Working Party brings together key stakeholders and provides guidelines for design, construction, adoption, and maintenance of SuDS. The latest action delivered by the SuDS Working Party is guidance aimed at developers, planners and others involved in water and drainage infrastructure. This guidance explains the necessary stages to obtain permissions and comply with standards and policies.[110] Figures on uptake of this guidance, however, are not available.

Actions are also ongoing to improve the understanding of the risk from surface water flooding. The 2014 flood maps produced by SEPA include surface water flooding, and were used to

[108] https://www.mgsdp.org/
[109] https://www.sepa.org.uk/regulations/water/diffuse-pollution/diffuse-pollution-in-the-urban-environment/
[110] https://www.sepa.org.uk/media/163472/water_assessment_and_drainage_assessment_guide.pdf

identify the 103 Potentially Vulnerable Areas for which Surface Water Management Plans are being developed. SEPA has piloted surface water flood forecasting to help urban areas improve their resilience to and preparedness for flooding. The development and wider roll-out of this service is currently being considered.

Between 2010 and 2015, Scottish Water invested £27.9million to reduce risk from sewers to properties with at least 1-in-10 annual chance of being flooded, and £13.5 million to develop five hydraulic, catchment scale models that informed the investment choices for 2025-2021.[111]

Between 2002 and 2012, the MGSDP, see Box 3.1 has delivered projects that reduced surface flood risk to about 7,000 properties. Some of the projects planned for 2013-2018 have been delivered to date, including £12 million spent on storage tanks to reduce the risk from sewer flooding in Springburn.[112]

Box 3.1: Glasgow surface water management case study

Surface flood risk accounts for 68% of the annual average damage from flooding in Glasgow City Centre, and 88% of the annual average damage from flooding in Glasgow City North.[113]

On 30th July 2002 the total average monthly rainfall usually experienced in Glasgow fell in just 10 hours, leading to major disruption affecting 500 properties as well as road and rail links, with subsequent damages of about £100 million. The flooding highlighted major problems with the ageing drainage system, primarily associated with the way that the main sewerage and drainage systems evolved over the last 100 years, but also relating to problems such as urban creep and the loss of permeable surfaces across the city.[114]

The Metropolitan Glasgow Strategic Drainage Partnership (MGSDP) was set up in the same year with the objectives of reducing flood risk and improving river water quality, whilst enabling economic development, improving habitats, and influencing planning authorities to consider surface water flooding within development planning. The partnership comprises organisations responsible for building, maintaining and operating the sewerage and drainage network of Metropolitan Glasgow, including Scottish Water, Glasgow City Council, Scottish Canals, South Lanarkshire Council, Clyde Gateway, Scottish Enterprise, Renfrewshire Council, East Dunbartonshire Council and SEPA.

Between 2002 and 2014, the MGSDP has delivered about £250 million of investment projects. These include:

- The £53M White Cart Flood Prevention Scheme that reduced potential flood damage by over £100 million to about 6,700 homes and business from the impacts of flooding of up to 1-in-200 years return period.
- The North Renfrew Flooding Project, a £10M project to protect more than 300 homes and businesses in North Renfrew from fluvial flooding influence by tidal conditions.
- The Camlachie Burn Overflow Project, a £14m project to construct a flood by-pass tunnel from the Camlachie Burn to the River Clyde.
- South Dalmarnock Regional SuDS, a £5M project to remediate a former power station site and create a regional SuDS pond, serving an area of circa 36 hectares.
- Colquhoun Park Food Alleviation Scheme, a £0.5M project for construction of two wetland areas to

[111] Scottish Water (2014) *Scottish Water Delivery Plan 2015 to 2021*
[112] http://www.scottishwater.co.uk/about-us/media-centre/latest-news/cabinet-secretary-sees-progress-in-glasgow-investment
[113] Clyde and Loch Lomond Flood Risk Management Strategy
[114] www.mgsdp.org

Box 3.1: Glasgow surface water management case study

reduce flood risk to 40 residential properties in Bearsden.

- As part of the MGSDP, Scottish Water has delivered a £2M Shafton Road project, where construction of a new CSO has resulted in sewer flooding risk being reduced for more than 60 properties in the west end of Glasgow, and the £1.2M Summerhill Road project in the north of Glasgow where new sewer storage has reduced flooding risk to a row of properties.[115]

The MGSDP is one of the fourteen National Developments identified in the National Planning Framework 3 as being needed to deliver Scotland's spatial strategy. [116]

Planned works include a £250million investment programme that Scottish Government is rolling between 2013 and 2018. This programme includes upgrading around 200 Combined Sewer Overflows (CSO's) and interventions to reduce excess surface water from known sewer flooding 'hot spots' around Glasgow.

Between 2016 and 2017, Scottish Water and the local authorities within the MGSDP will work to deliver catchment studies and Surface Water Management Plans identified in the Flood Risk Management Strategies.[117]

The MGSDP reports that a key challenge for all partners will be to deliver an appropriate balance between new and retrofitted grey, green and blue infrastructure to ensure a sustainable and resilient metropolitan area for future generations.

Source: Metropolitan Glasgow Strategic Drainage Partnership www.mgsdp.org/

Is progress being made in managing vulnerability?

Although policies are in place and actions are being delivered to reduce surface water flood risk, a number of trends suggest that vulnerability is still increasing.

Since 2002, about 7,000 properties have benefited from reduced surface flood risk in Metropolitan Glasgow. From the 2010 baseline, Scottish Water has also reduced the risk to 68 properties that had at least 1-in-10 annual chance of being flooded from sewer water, and decreased by 17% the number of flooding incidents from main sewers due to heavy rain. Scottish Water reported that its 'Keep the cycle running smoothly' campaign contributed to a 10% reduction in the number of blocked drains and sewers.[118]

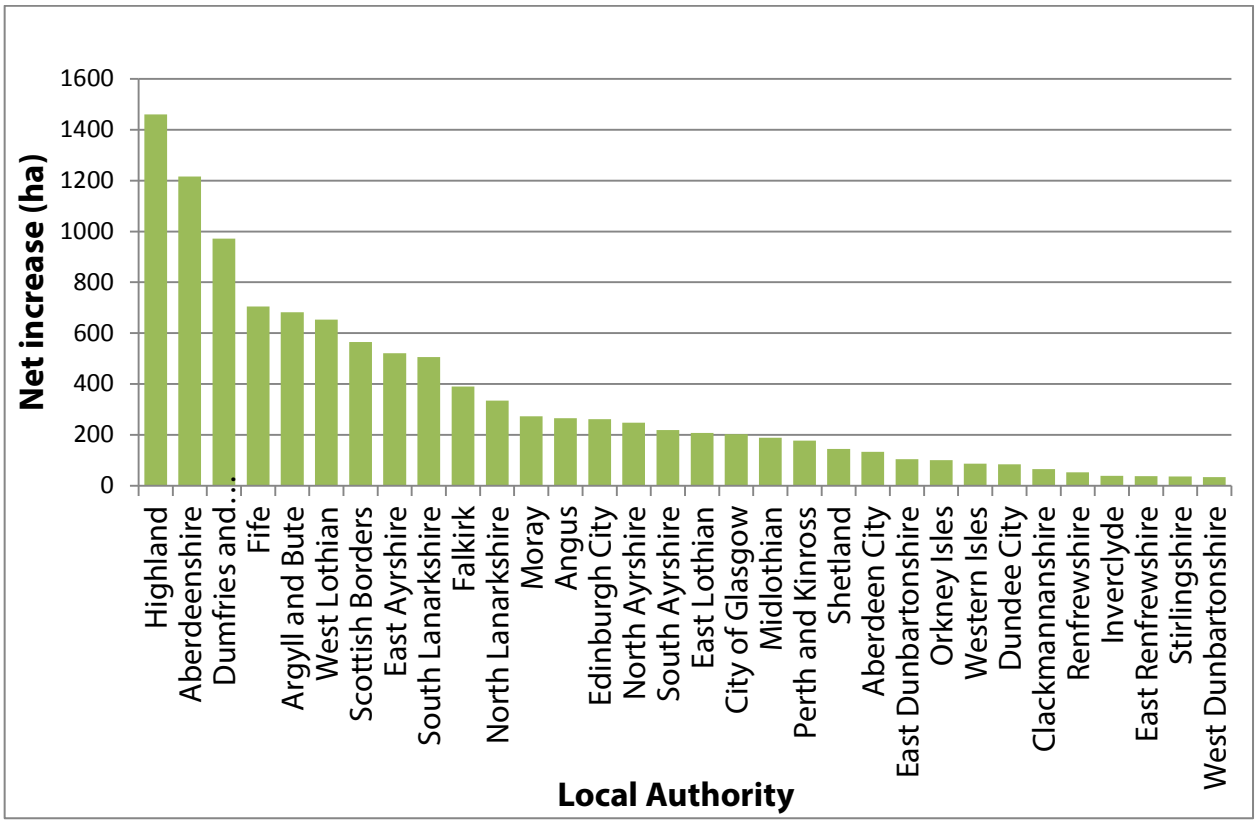
Despite this progress, surface water flooding contributes to 23% of the total annual average damage from flooding in Scotland.[119] About 28,000 properties in Scotland have at least 1-in-200 annual chances of being flooded by surface water,[120] of which over 9,000 properties are located within the Potential Vulnerable Areas around Glasgow City.[121] Over 300 residential properties in these areas have at least 1-in-10 annual chance of being flooded from sewers.

Permeable surfaces help to retain and slow the movement of water before it enters surface water sewers, combined sewer systems or open watercourses, thus reducing the likelihood of

[115] http://www.scottishwater.co.uk/investment-and-communities/your-community/glasgow-investment
[116] https://npfactionprogramme.com/national-developments/
[117] SEPA Flood Risk Management Strategies http://apps.sepa.org.uk/FRMStrategies/
[118] Scottish Water Annual Report and Accounts 2014/15.
[119] SEPA Flood Risk Management Strategies. http://apps.sepa.org.uk/FRMStrategies/
[120] CxC indicator (2015) BB1: Property at risk of flooding
[121] Clyde and Loch Lomond Flood Risk Management Strategy, SEPA

these being overwhelmed and causing flooding. However, between 2008 and 2015, the area of impermeable surfaces in Scotland increased by 7.5% (corresponding to a net increase of more than 101 km^2)(Figure 3.3).[122] Whilst this only amounts to about 1% of the total land area (including inland water), no local authorities have seen a net decrease in impermeable surfacing, including those with high risks of surface water flooding. For example, the impermeable surface in Glasgow City increased by 3%.[123]

Figure 3.3: Net increase in area of impermeable surface in each local authority area, 2008-2015



Source: ClimateXChange (2016) Proportion of local authority areas with impermeable surfaces: Scotland.

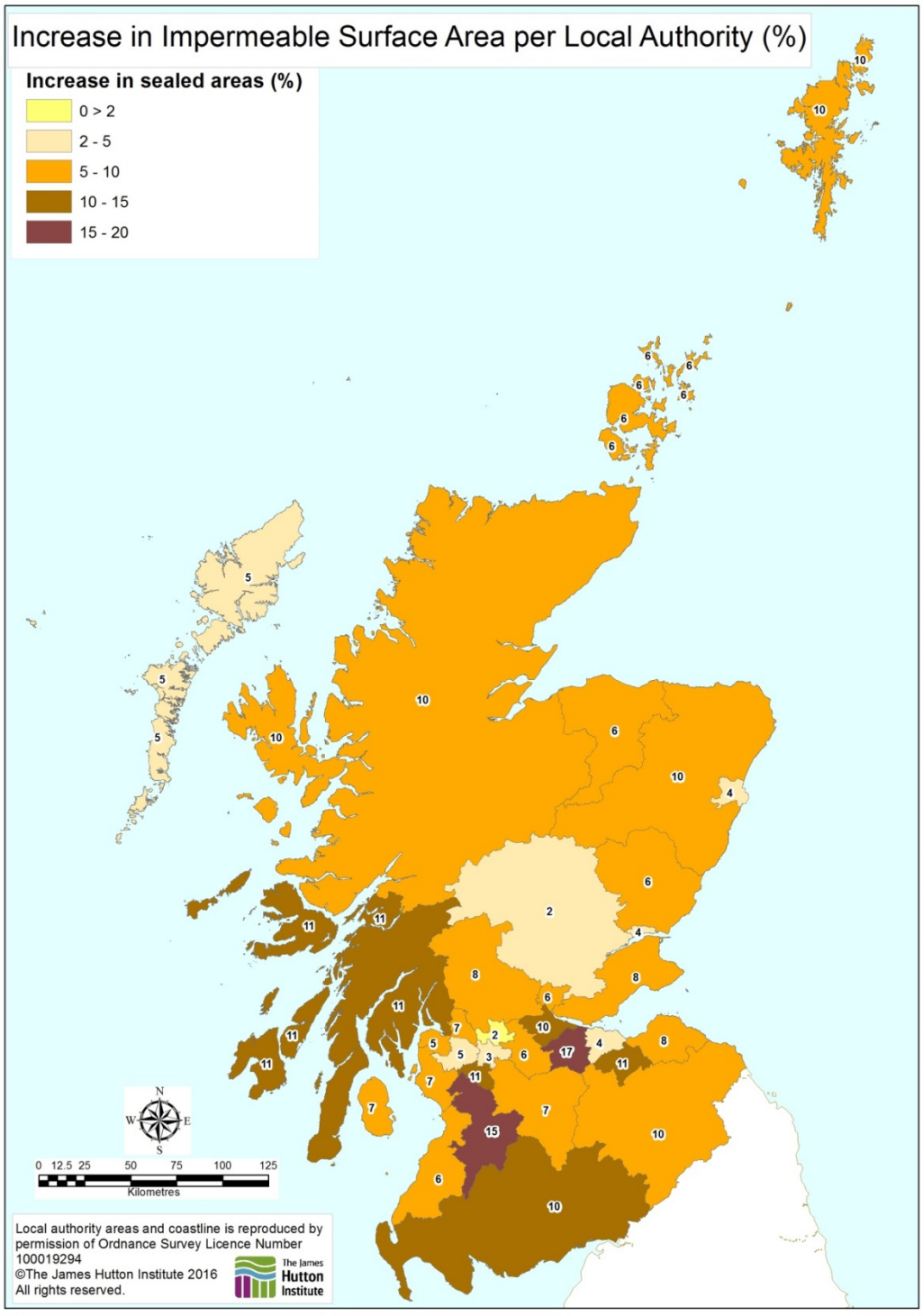
In some cases, increases have occurred in areas currently with a relatively low risk of surface water flooding (Figure 3.4).[124] However, some more densely built-up local authorities have seen increases, such as West Lothian (17%) and Mid-Lothian (11%). In these areas, surface flooding contributes to at least half of the average annual damages from flooding.

As might be expected, the area of impermeable surface has been increasing in councils that have seen high population growth in recent years, such as East Lothian and Mid Lothian. This suggests that a vulnerability to surface water flooding and the number of properties exposed

[122] ClimateXChange (2016) Proportion of local authority areas under impermeable surfaces: Scotland.
[123] Ibid.
[124] For example, Dumfries and Galloway have seen increases in impermeable surfaces of 10% between 2008 and 2015, but less than 1% of the surface area is already impermeable. Surface water flooding contributes to less than 10% of the total flood risk in most of the PVAs in Dumfries and Galloway. However there are PVAs, such as Dumfries East, in which surface water flooding contributes to 80% of the annual average damages.

are both increasing in these areas, which could lead to further increases in risks of surface water flood risk as the climate changes.

Figure 3.4: Increase in the area of impermeable surface by local authority



Source: ClimateXChange (2016) *Proportion of local authority areas under impermeable surfaces: Scotland*. Contains or is based on information supplied by The James Hutton Institute.

On average, nearly one-third (31%)[125] of the footprint of an average residential property is impermeable, although the values range from 10% to 90% depending on factors like the size of gardens. This implies that design choices could significantly contribute to reducing the area of impermeable surfaces in new developments. However, there is no evidence on the extent to which existing design guidelines and regulations are implemented, or their impact on reducing the risk of surface water flooding. There is a risk that sewer and surface water flooding may be exacerbated by the paving over of front gardens in urban areas. As only 4% of all UK residential paving sales in 2013 were of a permeable design, it is highly likely that the majority of surfaces being used to pave over front gardens are impermeable (e.g. concrete block paving, asphalt, etc.).[126]

The deployment of SuDS in new development appears to be mixed. Out of 40 planning applications analysed in 2016, 21 (53%) explicitly stated that they would manage surface water using SuDS.[127] However SEPA reports that deployed SuDS to date generally are not designed to manage extreme rainfall events, with most only able to deal with a 1-in-30 year event.[128]

There is no up-to-date register or monitoring of SuDS uptake in new development. The most up-to-date SuDS database is from 2002.[129] This reported nearly 4,000 SuDs systems in Scotland at the end of 2001, corresponding to about 767 SuDS sites.

In the Scottish Government's May 2016 Adaptation Progress Report it was noted that the SuDS Working Party have raised concerns about the effectiveness of SuDS implementation in Scotland. In response, Scottish Government established an additional working group to report on SuDS implementation,[130] although the exact remit and timetables have yet to be announced.

RECOMMENDATION 11: The Scottish Environment Protection Agency should ensure the next Flood Risk Management Strategies monitor and report:

1) The impact of local flood risk management plans in reducing surface water flood risk, including in relation to managing urban creep.

2) The number and capacity of SuDS installed in new developments and of other drainage assets retrofitted with SuDS.

3) The number of planning applications for new developments in the floodplain that were granted, and within these, the number of applications for which SEPA advice was sought and the number of applications to which SEPA objected.

4) The number and location of new homes and other properties built in areas of flood risk.

[125] Taken from observations of nine local authorities.
[126] ASC, 2014.
[127] LUC, 2016. *Assessing the consideration of flood risk for Scottish local planning authorities, prepared for ClimateXChange*. http://www.climatexchange.org.uk/adapting-to-climate-change/assessing-consideration-flood-risk-scottish-local-planning-authorities/ Note: The majority (80%) of the applications surveyed were for residential development.
[128] Communication with SEPA.
[129] http://www.sniffer.org.uk/files/4013/4183/7992/SR0209.pdf
[130] Scottish Government (2016) Progress update.

3.3.3 Development in flood risk areas

Is there a plan?	 Green	Scottish Planning Policy requires local planning authorities to prevent development which would have a significant probability of flooding or increase flood risk elsewhere. SEPA has a statutory role to provide advice to planning authorities about new development proposals in areas of flood risk. All 34 local planning authorities in Scotland are advised to produce a Strategic Flood Risk Assessment (SFRA) to inform their local development plan. Developers must also produce site-specific flood risk assessments for planning applications in areas of flood risk.
Are actions taking place?	 Red	Half of the local planning authorities surveyed did not undertake a SFRA to inform their local development plan. 21 of 528 planning decisions in 2012 (the latest data available) were granted contrary to SEPA advice. A 2016 survey of 40 planning applications found that three-quarters had not conducted site-specific flood risk assessments.
Is progress being made in managing vulnerability?	 Grey	There are no data available on the trends in floodplain development in recent years. A report carried out by Dundee University in 2015 is yet to be published.

Is there a plan?

National planning policy is in place that requires local planning authorities to account for current and future flood risk.

Scottish Planning Policy (SPP) 2014 is the main policy applicable to local planning authorities on both strategic planning and development management. There are 34 local planning authorities in Scotland consisting of 32 local authorities and 2 national park authorities. The SPP directs local planning authorities to take the probability of flooding from all sources (coastal, fluvial, pluvial, groundwater, sewers and blocked culvers) into account when preparing development plans and in determining planning applications. The SPP also requires that local planning authorities take account of the projected impacts of climate change.

The SPP directs local planning authorities away from 'development that would have either a significant probability of being affected by flooding, or increasing the probability of flooding elsewhere'. It promotes flood avoidance through safeguarding storage and conveying capacity as well as flood reduction through natural and structural methods. Development in areas that would require new coastal defences is not considered acceptable. The SPP also states that piecemeal reduction of the functional floodplain should be avoided given the cumulative effects of reducing storage capacity.

All local planning authorities are advised by the SPP to undertake Strategic Flood Risk Assessments (SFRAs) to inform their Local Development Plans (LDPs), where the area is deemed to be in a medium to high flood risk category according to the SEPA flood risk assessment. SFRAs should be at a more detailed scale than the SEPA flood risk assessment, and should take into account relevant Flood Risk Management Strategies and River Basin Management Plans. Flood Risk Assessments (FRAs) are also required for individual planning applications located in areas of medium (1-in-200 year) to high (1-in-10 year) flood risk, as identified in SEPA's flood maps. Areas at medium flood risk or higher may be suitable for residential, institutional, commercial and industrial development within built-up areas, provided risk management measures to the appropriate standard either already exist, are under construction, or are a planned measure in a current flood risk management plan.

SEPA is responsible for providing flood risk advice to local planning authorities when preparing LDPs and when considering individual planning applications. The draft LDPs are tested against the SPP through an examination process[131] carried out by an independent assessor appointed by Scottish Government. Local authorities must take notice of this assessment, however the wording of the SPP is not legally binding and subject to interpretation.

Scotland's National Marine Plan includes a requirement for Regional Marine Plans to align with FRMPs and LDPs, taking land-sea interactions into account.[132]

Are actions taking place?

National planning policy on flood risk does not appear to be consistently applied by local planning authorities.

An analysis of 16 planning authorities has shown that nearly half had not produced a Strategic Flood Risk Assessment for their Local Development Plans, despite being requested by SEPA in all but two cases. During the examination process, the draft Local Development Plans were found to be unsatisfactorily in applying the SPP principles of taking a precautionary approach to flood risk from all sources, flood avoidance, safeguarding storage and conveying capacity; and flood reduction through natural and structural management methods. These findings suggest that there is a weakness among local authority planning departments in considering flood risk. In all the cases included in the analysis, issues were overcome when SEPA advice was requested or when the draft LDPs was taken through examination.

SEPA's advice to LPAs on individual planning applications appears to mostly be taken into account, but this advice might not be consistently sought. Data from 2012 shows that 21 of 528 (5%) planning applications in flood risk areas did not follow SEPA's advice.[133] A more recent study of 40 planning applications (2016) located within areas at flood risk found that 31 (76%) were not supported by a site-specific Flood Risk Assessment (FRA), despite this being a requirement of the SPP.[134] This suggests that SEPA might not be consulted as often as it should be on sites at risk of flooding as otherwise SEPA would have informed them an FRA is required.

[131] The examination of local development plans is a process required by law during which plans are assessed against issues raised following a public consultation. http://www.gov.scot/resource/0039/00396852.pdf

[132] http://www.gov.scot/Resource/0046/00465865.pdf

[133] Ball, T. Werrity, A. Illsley, B. and Rennie, A. (2015) *Assessing the Effectiveness of SEPA's Flood Risk Advice in Planning Decisions*, CREW, CRW2012/9. http://www.crew.ac.uk/publications

[134] LUC (2016) *Assessing the consideration of flood risk for Scottish local planning authorities, prepared for ClimateXChange*. http://www.climatexchange.org.uk/adapting-to-climate-change/assessing-consideration-flood-risk-scottish-local-planning-authorities/

Is progress being made to manage vulnerability?

It is not possible to assess whether progress is being made due to there being no data available on trends in floodplain development in Scotland.

The mixed implementation of national planning policy on flood risk suggests that inappropriate development may be going ahead on the floodplain. However, no data are collected by Scottish Government, SEPA nor local planning authorities on the number and type of properties built in flood risk areas.

A study of floodplain development was carried out by Dundee University to inform the ASC's assessment. Interim results suggest the rate of development might be higher in the floodplain than outside the floodplain. However, this indicator has not yet been finalised, as further quality assurance of the underlying datasets is required.

3.3.4 Resilience of buildings to extreme wind and rain

Is there a plan?	 Amber	Building standards are in place for flood resilience, moisture penetration from heavy rain, heating and overheating, ventilation and condensation. However, there is no specific plan for retrofitting existing buildings. The potential for unintended consequences from retrofitting in terms of building performance is not well understood. Historic Environment Scotland's climate change plan (2012-2017) describes the work being done to increase the resilience of the historic building stock.
Are actions taking place?	 Green	Research has started on identifying the most suitable building and retrofit measures, and there is an action plan underway for historic buildings being carried out by a joint agency working group.
Is progress being made in managing vulnerability?	 Amber	Data from 2004/5 suggests around 30% of homes in Scotland show extensive signs of disrepair. However, there has also been a small increase in dwellings free from disrepair since 2012. Around 4% of the Scottish housing stock shows signs of dampness, and 11% of condensation (based on data from 2012). There have been no significant changes in these levels since 2002.

Is there a plan?

Provisions are in place for new buildings to be designed and built so as to minimise susceptibility to climate change impacts. However there are no plans in place to support retrofitting for the existing building stock.

Provisions for new buildings to be designed and built to be less susceptible to the impacts of climate change are included in Building Regulations under the Building (Scotland) Act 2003. The guidance that accompanies the Building Regulations specifically highlights the potential impact

of climate change stating "designers should be aware of the impact that climate change could have on the fabric of buildings through increased rainfall and temperatures. Higher wind speeds and driving rain should focus attention to improve design and quality of construction and to the protection of the building fabric from long term dampness." [135]

Historic Environment Scotland's Climate Change plan (2012-2017) recognises that changes in extremes of wetting and drying could lead to accelerated decay of stonework and that condensation and dampness could lead to structural collapse if not treated. Historic Environment Scotland will provide support and guidance on further strategies to increase the resilience of the broader historic environment.[136]

There are, however, currently no plans to deliver widespread retrofitting of the existing building stock.

Are actions taking place?

Actions in the SCCAP related to improving the resilience of building fabric focus on historic buildings.

The main policy in the SCCAP to act against the risk to buildings is Historic Environment Scotland's Climate Change plan. There is also an action to establish a joint agency working group to help protect historic sites. To date, this working group has enabled the start of a flood risk assessment for Historic Scotland's estate of 345 properties.

Historic Environment Scotland's public bodies report states that they have been undertaking a number of actions predominantly on their public estate however also running lecturers and events to disseminate their knowledge and research on current and future impacts of climate change on the historic environment both to the public and across their staff base. In addition they have started an apprenticeship on traditional skills and have set up 'Engine Shed', a conservation centre specifically to pass on knowledge and experience.

Is progress being made in managing vulnerability?

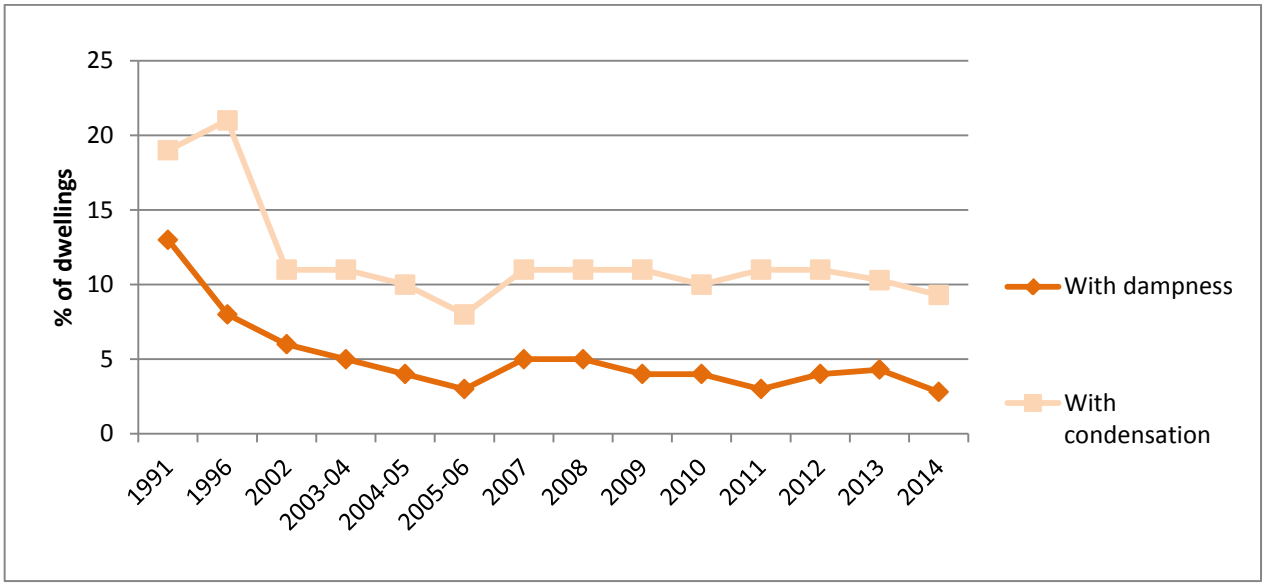
The number of dwellings free from disrepair increased slightly between 2013 and 2014, though over half of buildings surveyed remain affected by disrepair. The proportion of buildings showing signs of damp and condensation have not changed significantly since 2003.

Buildings that are in a good state of repair are more likely to be resilient to extreme wind and rain. Data collected annually via the Scottish House Condition Survey provides a useful indicator of vulnerability. This shows the proportion of dwellings free from any disrepair has increased from 22% in 2013 to 27% in 2014 and that there has been an overall decrease in all types of disrepair during this period.[137] However in 2014, 53% of dwellings were found to have disrepair to 'critical elements', defined as aspects central to weather-tightness, structural stability and preventing deterioration of the property. Nearly three-quarters (72%) of pre-1919 buildings are in a critical state of disrepair.[138]

[135] http://www.gov.scot/resource/buildingstandards/2015domestic/chunks/ch01.html#d5e16
[136] Historic Scotland (2011) *A Climate Change Action Plan for Historic Scotland 2012-2017*
[137] Scottish Government (2015) *Scottish House Condition Survey*. http://www.gov.scot/Resource/0049/00490947.pdf
[138] Ibid.

The Scottish House Condition Survey also measured levels of condensation and damp. With climate change these levels are projected to increase. In 2014 2.8% of the household stock showed some degree of penetrating damp, a slight decrease from 2013, and a very small percentage (0.5%) showed signs of rising damp. Just over 9.3% had condensation.[139] These numbers have remained more or less constant since 2003/4 (Figure 3.5).

Figure 3.5: Dampness and condensation in the Scottish housing stock, 1991-2014



Source: ClimateXChange indicator BB17. Scottish Government Scottish House Condition Survey.

3.3.5 Water demand in the built environment

Is there a plan?	Green	The Water Resources (Scotland) Act (2013) places a duty on Ministers to take steps to develop the value of water resources. Scottish Water's water efficiency plan (2011 to 2015) includes measures to educate customers on water efficiency and to reduce leakage in the network. There are currently no plans in place to increase the penetration of water metering from its current low level.
Are actions taking place?	Green	Scottish Water is undertaking water efficiency trials to understand the relative costs and benefits of different measures to manage demand.
Is progress being made in managing vulnerability?	Amber	Consumption per person has decreased since 2008, but is still higher than in England and other European countries. Only around 400 households out of 2.4 million are metered. Leakage as a proportion of public water supply fell between 2006/07 and 2014/15, but remains higher than other European countries.

[139] Ibid.

Climate change is expected to restrict the supply of water whilst population growth will increase demand. These impacts are, however, projected to be relatively modest in Scotland at least until the 2030s, as population growth is expected to be offset by reductions in per capita consumption and leakage. The latest research states that Scotland currently has a comfortable 22% (414Ml/d) surplus capacity in the public water supply compared to water use. However, not all individual Water Resource Zones are in a surplus position.[140]

Is there a plan?

Plans are in place to manage water demand through the Water Resources (Scotland) Act.

The Water Resources (Scotland) Act (2013) places a duty on ministers, and Scottish Water, to take steps to develop the value of water resources and to do so in ways designed to promote the sustainable use of these resources.

Scottish Water produces a 25-year Water Resource Plan (WRP) once every five years. This plan sets out how it will provide the required minimum level of service for each Water Resource Zone (WRZ). The requirement is for normal supplies to be maintained with no restrictions for customers in the driest year that would be expected over a 40 year period. In its 2015 WRP, Scottish Water aims to reduce demand by continuing to manage leakage at economic levels and implementing its water efficiency plan and promotion of water efficiency measures, particularly in the WRZs at most risk of failing to meet its target level of service.

Are actions taking place?

As part of its ongoing core function, Scottish Water has actions in place to reduce leakage and investigate other measures to manage demand.

Since 2006, the Water Industry Commission for Scotland has agreed annual targets with Scottish Water to continually reduce leakage and move towards an economic level of leakage. During the period 2015-21, Scottish Water aims to reduce leakage to below 500 Ml/d (Maximum Likelihood Estimate) through more proactive leakage detection and repair, pressure management and modulation, improvements in repair cycle times and selected mains rehabilitation.

Scottish Water's Water Efficiency Plan for 2011 to 2015 included a number of trials to understand the costs and benefits of different measures to manage demand. This has involved recruiting customers to allow installation of monitoring to capture data on their water usage and assessing the impact of a range of measures such as provision of water saving advice and installation of water saving devices. Between 2015 and 2021, these trials will continue and Scottish Water will distribute 49,000 water efficiency advice packs to household customers in areas more susceptible to water supply shortages.

Is progress being made in managing vulnerability?

Consumption of water per person and leakage rates have decreased since 2008/09, but remain high compared to other North West European countries.

Average water consumption per person in Scotland has fallen from around 153 litres per household per day (l/h/d) in 2008-2009 to 149 l/h/d in 2014-2015. This is higher than in England

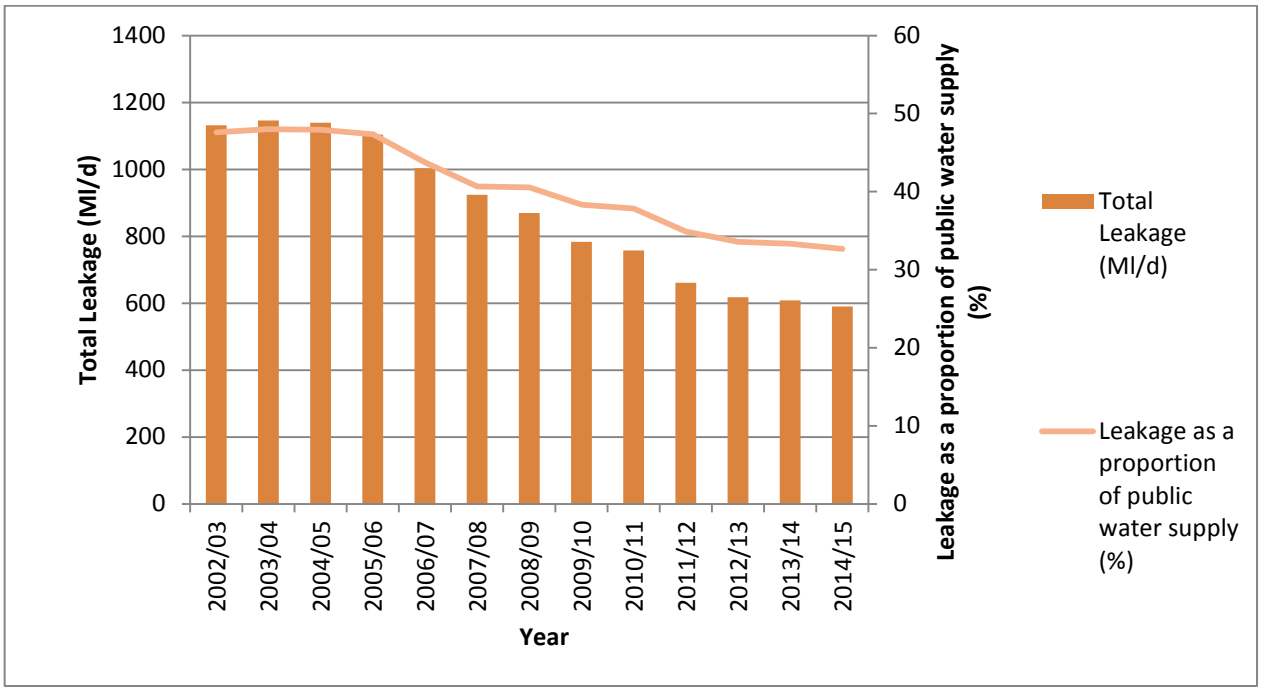
[140] Ibid.

(141 l/h/d) and significantly higher than in a number of other European countries, including Belgium, Denmark, Germany and the Netherlands.[141]

Of the 2.4 million residential properties in Scotland, only around 460 were metered in 2014-15. To have an above ground meter installed in their property, household customers have to pay between £190 and £640 depending on the size of meter.[142]

Scottish Water has consistently met targets on reducing leakage and is currently operating at the economic leakage level, where leakage levels and management costs are balanced. Between 2006/07 and 2014/15 leakage fell from 1,004 Ml/d (44% of public water supply) to 590 Ml/d (33%) (Figure 3.4).[143] However, the leakage rate in Scotland remains higher than estimated losses from urban water networks in other European countries.[144]

Figure 3.6: Leakage as a proportion of public water supply, 2002/03 - 2014/15



Source: Scottish Government (2015) Key environmental statistics for Scotland.

RECOMMENDATION 12: The Scottish Government should review before the next SCCAP whether further action is required to deliver and sustain reductions in average water consumption per person in Scotland. As part of this review, Scottish Water should publish the outputs of their water efficiency trials, including an assessment of the impact of metering.

[141] Aquaterra (2008) *International comparisons of domestic per capita consumption*. Report for the Environment Agency.
[142] Scottish Water (2016) *Schedule of rates – meter charges for 1st April 2016 to 31st March 2017*
[143] Maximum Likelihood Estimate was 531 Ml/d in 2014/15.
[144] European Environment Agency (2003). *Water use efficiency (in cities): Europe*. http://www.eea.europa.eu/data-and-maps/indicators/water-use-efficiency-in-cities-leakage

3.3.6 Design and location of new infrastructure

Is there a plan?	 Green	The National Planning Framework 3 and Scottish Planning Policy both require that the short and long term impacts of climate change are taken into account in the design and location of new infrastructure. Strategic development plans for Scotland's four largest city regions note the general need to plan for climate change, but do not explicitly identify measures that may limit the vulnerability of new infrastructure to future climate impacts.
Are actions taking place?	 Amber	There is some evidence that weather-related hazards are being accounted for in the design of new infrastructure projects, but it is less clear whether the long-term impacts of climate change are explicitly factored in to design specifications.
Is progress being made in managing vulnerability?	 Grey	There has been no assessment of whether new infrastructure development is being sited and designed in ways that manage long-term risks from climate change.

Much of the investment planned over the next decade will be new large scale developments such as power generating stations (including wind farms), electricity transmission and distribution networks, gas pipelines, enhancements to the strategic road and rail networks, and the expansion of airports, harbours and ports. Major new rail routes are being created or proposed (for example a high speed rail link between Edinburgh and Glasgow).

Is there a plan?

A statutory framework is in place that requires the consideration climate change in the design and location of new infrastructure.

The development of new infrastructure provides an opportunity for infrastructure providers to ensure that climate change is fully incorporated into decisions on design and location. This will often be more straight-forward and more cost-effective than having to retrofit measures when upgrading and renewing assets at a later stage.

The 2014 statutory National Planning Framework 3 (NPF) lays out a strategy and priorities for development in Scotland over the next 20-30 years and states that development should facilitate adaptation to climate change. Strategic development plans exist for Scotland's four largest city regions: Glasgow and the Clyde Valley; Aberdeen City and the Shire; Dundee, Perth, Angus and North Fife; and Edinburgh and South East Scotland. These plans give direction on development priorities and on where development should be located as well as enabling co-ordination between the local development plans of the constituent local authorities. The NPF3 requires that climate change adaptation should be taken into account, but does not identify measures required to improve infrastructure resilience.

A non-statutory infrastructure investment plan lays out how the Scottish Government intends to invest in large scale infrastructure over the next 20 years. This plan follows the principles laid out in the NPF3.

Are actions taking place?

Infrastructure designers in the UK have access to climate projection data via UKCP09, and best practice in engineering design has evolved to take these data into account. However, there is not specific evidence from Scottish designers about the extent to which climate projections are being included in infrastructure design.

Is progress being made in managing vulnerability?

There is no evidence currently collected on whether new infrastructure is designed and located according to the sustainability and adaptation principles set out in NPF3.

3.3.7 Resilience of infrastructure services to extreme weather events

Is there a plan?	 Green	Secure and Resilient: A strategic framework for critical national infrastructure (2011) sets national policy on the resilience of infrastructure in Scotland. It specifically outlines approaches and policies to improve infrastructure performance in extreme weather.
Are actions taking place?	 Amber	Action is evident in most areas, notably in the regulated infrastructure sectors that have routine reporting requirements. Evidence that climate change risk assessments have been performed, and vulnerabilities addressed, is weaker for commercial operators such as ports, airports and ICT.
Is progress being made in managing vulnerability?	 Grey	Even where evidence of action is available, it is not generally possible to establish how much progress has been made in improving the resilience and performance of infrastructure services in severe weather. Climate change will, to a degree, counteract the actions being taken by all sectors. This will mean that further and continuing investment in resilience will need to be made over the coming decades.

This section provides an overview of resilience policy covering the whole of Scottish infrastructure. Progress with specific sectors (energy, water supply, ports, airports and ferries, road and rail and ICT) is assessed in the subsequent sections (3.3.7a to 3.3.7e).

Is there a plan?

A policy framework exists for ensuring critical national infrastructure is resilient to risks including those from climate change.

The Scottish Government's Secure and Resilient: A strategic framework for critical national infrastructure (2011)[145] provides the policy framework for ensuring the resilience of critical national infrastructure (CNI)[146] to the risks laid out in the National Security Risk Assessment (NSRA) and the National Risk Assessment (NRA). The NRA is carried out annually and assesses risks over a five year period. The NSRA measures potential impact against the likelihood of risks over a 20 year timescale. The most recent (2015) NSRA includes risks from major natural hazards.[147]

For reserved matters, the Cabinet Office Critical Infrastructure Resilience Programme was established in 2007. The work is sponsored by the National Security Council, chaired by the Prime Minister. The programme aims to support operators in both the public and private sectors to build the resilience of their services. In 2009, following recommendations in the Pitt Review, the Cabinet Office worked with government departments and the devolved administrations to develop sector resilience plans. The sector resilience plans focused initially on resilience to flooding, but have been broadened to now consider a range of weather-related hazards set out in the National Risk Assessment. A public summary of the plans is published each year.

Are actions taking place?

Infrastructure operators have voluntarily reported on progress on their adaptation plans and actions. This reporting is due to continue as it becomes mandatory for Public Bodies.

The SCCAP highlights that risk assessments are being undertaken across each of the CNI sectors that report annually to the Cabinet Office. Action to improve resilience is more apparent within the economically-regulated sectors such as power, water, road and rail. The Adaptation Reporting Power (ARP) was intended to bring consistency and transparency in reporting across all sectors. However, reports under round one followed a range of different formats, and for round two reporting has been made voluntary. Those operators that are declining to report may be those that are the least prepared for severe weather. ARP reports that have been produced to date have in general presented principles and general statements rather than providing specific, quantitative evidence that allows progress to be measured.

Under the Climate Change (Scotland) Act 2009, 151 public bodies will be required to report annually on climate change adaptation. This includes infrastructure related bodies of Scottish Water, Transport Scotland and seven transport partnerships. Six of the transport partnerships and Scottish Water voluntarily reported in November 2014/15. The reports from the transport partnerships were lacking in evidence of any specific climate change adaptation action with two directly stating they were not carrying out any actions. Others refer to their current risk registers, although one is working with the Climate Ready Clyde initiative and another stated they had a climate change plan (though was not provided). Reporting in 2015/16 will be mandatory. However, as this does not include private or commercial infrastructure operators it only provides a partial picture of action.

[145] Scottish Government (2011) *Secure and Resilience: A strategic framework for critical national infrastructure in Scotland*. http://www.gov.scot/Resource/Doc/346469/0115308.pdf

[146] Critical National Infrastructure is defined as those assets whose loss would have major detrimental impacts to the economy and/or result in loss of life.

[147] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/478936/52309_Cm_9161_NSS_SD_Review_PRINT_only.pdf

Is progress being made in managing vulnerability?

Assessments still need to be made of the vulnerability of infrastructure and their systems to extreme weather.

Across all sectors it is difficult to assess the true vulnerability to extreme weather-related hazards. To do so requires consideration of the resilience of infrastructure assets and how they combine to create systems. Networks may be resilient even if individual assets fail, if services can be provided by alternative means. However, because of their remoteness, there is no network redundancy in some parts of Scotland's systems. Recognising the importance of critical infrastructure, the Cabinet Office has set a benchmark that 'as a minimum essential services provided by Critical National Infrastructure (CNI) in the UK should not be disrupted by a flood event with an annual likelihood of 1 in 200 (0.5%)'. It is not clear how this benchmark has been interpreted by each sector, and whether this minimum standard of flood resilience is now in place.

RECOMMENDATION 13: The Scottish Government should work with all infrastructure sectors before the next SCCAP to develop consistent incident reporting, together with indicators of network resilience and performance, and the implementation of resilience measures, to allow improvements in resilience to extreme weather events to be measured over time.

3.3.7a Energy networks – generation, transmission and distribution

Is there a plan?	Green	The regulatory framework for gas and electricity transmission and distribution companies, including financial reward and penalty regimes, incentivises investment in resilient services. Cross-industry standards for improving network resilience to severe weather have been agreed. Electricity generation companies have been proactively assessing climate-related to risks to their operations for a number of years.
Are actions taking place?	Amber	The main relevant action in the SCCAP is to develop research on the impacts of climate change on the energy sector, has been dropped. However, across Scotland there are resilience projects taking place. Electricity transmission and distribution companies in Scotland are delivering a programme of investment agreed by the regulator to reduce risks from flooding and storms.
Is progress being made in managing vulnerability?	Green	Electricity transmission and distribution companies are transparently taking steps to improve standards of flood protection for critical assets. The national transmissions network means that electricity supplies are unaffected even if individual power stations are impacted by severe weather.

In Scotland, electricity is generated by a mixture of renewable and non-renewable sources. Oil, gas, and nuclear energy accounted for 41% of electricity provision in 2014.[148] Onshore and offshore wind, wave, tidal and hydroelectric power provided the remaining 21%. Of the three gas and nuclear power stations in Scotland, two are located in flood risk Potentially Vulnerable Areas (PVAs). However, there have been no recorded incidences of power outages as a result of flooding at these power stations. The national coverage and reliability of the transmissions network means power can be routed to customers even if individual power stations are forced to cease generation.

Electricity networks by their nature are exposed to range of climate hazards. Between 1995 and 2012, 35% of all customer minutes lost from high-voltage substations in the UK were due to natural hazards. High winds and storm damage were the major causes of weather-related disruption. Flooding of substations caused the longest average length of disruption per incident during the same time period. Lightning, snow and ice can also cause power cuts. Weather-related disruptions to the transmission network are at near-zero levels.

Gas transmission networks are generally less exposed to climate hazards than electricity networks. However, any failures with gas transmission can result in serious consequences due to the risk of explosions, as was seen in the winter 2015/16 flooding when the loss of a bridge resulted in gas pipelines rupturing. The Health and Safety Executive therefore places strong emphasis on gas transmission and distribution operators and National Grid Gas to maintain a safe system.

Is there a plan?

Energy policy at the UK level requires companies to improve network reliability and reduce the frequency of power cuts, whilst specific energy companies have included some aspects of climate change planning in their business plans.

Energy policy is a reserved matter and is set at a UK level. The economic regulator, Ofgem, has established the Revenue Incentives, Innovation and Outputs scheme (RIIO) that requires gas and electricity transmission and distribution companies to provide safe and reliable services, including during periods of extreme weather. The 2015 RIIO for electricity distribution specifically requires companies to improve network reliability and reduce the frequency of power cuts.[149]

The electricity transmission and distribution sector has developed technical standards for managing current and future risks from flooding and storms. These provide a consistent approach across the industry to identifying the most critical assets at the highest level of risk in order to prioritise action. Application of these standards is used to make a business case to the economic regulator for funding resilience measures that provide value for money to the consumer. The process includes an assessment of the risks from climate change.

The inclusion of climate risks within energy supplier business plans is necessary for future planning in the energy industry. Electricity transmission and distribution companies have agreed business plans with Ofgem to address river and coastal flooding risks by the early 2020s and these business plans are being implemented.

[148] DECC (2015) *Energy trends.* https://www.gov.uk/government/collections/energy-trends
[149] Ofgem (2015) *Strategy decision for the RIIO-ED1 electricity distribution price control*. https://www.ofgem.gov.uk/ofgem-publications/82935/riioed1decreliabilitysafety.pdf

The electricity generation companies adopted a coordinated approach to assessing their risks from climate change under the ARP process. The Association of Electricity Producers (Energy UK) agreed a common template for categorizing and reporting risks, which were then used by the individual energy company ARP reports in 2011 and 2015. The Energy Networks Association (ENA) played a similar co-ordination role for both ARP rounds for the energy transmission and distribution companies.

Are actions taking place?

Energy providers have reported on their actions under the Adaptation Reporting Power.

Four Scottish energy bodies reported progress in 2015 on their climate change adaptation actions via Defra's second Adaptation Reporting request. These represent generation, transmission and distribution networks.

- SP Energy Networks, constructs, maintains and repairs the electrical equipment and network assets that provide electricity to around 3.5 million homes and business in the south of Scotland.[150] Flooding of sub-stations was considered the greatest risk to SP Energy Networks businesses; therefore 52 new flood defence measures have been introduced to protect sub-stations since 2010. Updates have also been made to flood risk assessments following revisions to SEPA flood maps. Additional work on emergency preparedness has been undertaken along with research into the impacts of heat. SP Energy Networks are also committed to continue to consider adaptation as new information comes to light.[151]
- Scottish and Southern Energy provides hydroelectric power to 740,000 customers on the mainland and islands, as well as owning a transmission network in northern Scotland.[152] They have considered that they flooding of sub-stations would be their greatest risk. However the storms of 2013/14 showed that wind causing trees to fall on lines was also a significant risk to maintaining services. They recognised that assets have long life times of around 30-80 years therefore action should be taken now to plan for future climate change.
- The Energy Networks Association is a trade association representing transmission and distribution networks companies. In collaboration with their members they developed guidance 'Engineering Technical Report ETR 138 - Electricity Substation Resilience to Flooding' that sets standards of acceptable flood risk, depending on the importance of the sub-station.[153]All network operators agreed that they will complete work to ensure sub-stations are protected to these levels by 2023. In the price control period from 2010 to 2015 distribution companies have spent £73million with a further £100million planned to be spent between 2015 and 2023.
- Energy UK is a trade association representing energy providers. Discussions with their members found that short-term weather events presented greater risk to generation than

[150] SP Energy Networks (2015) *Climate Change Adaptation Report, Round 2*. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/479266/clim-adrep-sp-energy-networks-2015.pdf

[151] Ibid

[152] Scottish and Southern Energy Power Distribution (2015) *Climate Change Adaptation Report Second Round*. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/478927/clim-adrep-sse-power-distribution-2015.pdf

[153] ENA (2015) *Climate Change Adaptation Reporting Round Two*. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/479267/clim-adrep-ena-2015.pdf

long-term trends in climate change and that although climate change did not present any new risks it increased the likelihood and severity of their risks. Actions completed since 2011 by their members have included works to tackle: the flooding of access routes to sites, storm surges, extreme high temperature impacts on gas turbines, drought, and changes in water abstraction legislation. Work still to be started in some cases includes measures to prevent on-site flooding.[154]

The primary action noted in the SCCAP is the development of an energy sector climate change impacts research programme to specifically look at the significance of increased energy demand and the potential reduction in energy efficiency as a result of climate change. This would be a helpful pre-cursor to developing a plan specifically for the sector. However, this action was reported as dropped in the May 2016 progress update report without explanation.

Is progress being made in managing vulnerability?

Flood risk assessments have been carried out for around half of major substations located in flood risk areas. There is no clear trend in the number of supply minutes lost as a result of flooding.

Only around 4% (43 of 1127) of major distribution substations in Scotland are located in flood risk areas.[155] Flood risk assessments have been carried out for 37 of these. [156] A study looked at a selection of 22 of these flood risk assessments and found that 19 had planned or implemented flood protection works and the remaining three were deemed not to need protection.[157]

The number of minutes lost as a result of interruptions to supply caused by flooding fluctuates considerably from year to year with no significant trend. However, since a peak in 2006 and subsequent highs in 2010 and 2011, lost minutes have been on an overall downward trend. This is similar to interruptions caused by severe weather as a whole, including rain, ice, wind and gales.

[154] Energy UK (2015) *Climate change risks & adaptation responses for UK electricity generation*. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/478938/clim-adrep-energy-uk-2015.pdf

[155] ClimateXChange (2015) BE5: Electricity substations located in areas at flood risk

[156] ClimateXChange (2015) BE7: Substations in areas at flood risk with completed Flood Risk Assessments

[157] Data is not available for the rest of the 21 of the 43 sites in flood risk areas.

3.3.7b Public water supply

Is there a plan?	 Green	Scottish Water's 25 year Water Resources Management Plan includes actions that will be taken to improve the resilience of public water supplies, taking account of climate change.
Are actions taking place?	 Green	Scottish Water has made commitments to ensure that no individual Water Resource Zones are in supply deficit by 2027 through the delivery of the investment already planned between 2015 and 2021 and to be agreed thereafter. During 2010-2015 Scottish Water undertook 12 research projects to understand the impact of climate change on their ability to provide reliable water and sewerage services.
Is progress being made in managing vulnerability?	 Amber	Significant investment is taking place to increase resilience of the public water supply and improve response to extreme weather events. The numbers of properties affected by unplanned interruptions to water supply has been declining since 2006. However, it is not possible to tell whether, over time, services are becoming more or less resilient to extreme weather, as these interruptions are not recorded separately.

Scottish Water provides nearly two billion litres of water per day, supplying 2.2 million households as well as non-domestic customers. Since 2008, when a retail market was opened, almost 190,000 business customers, public sector and charitable organisations have been able to choose their water and sewerage supplier. Currently there are about 20 water and sewerage companies serving Scottish businesses.[158]

The recent extreme weather in winter 2015/16 saw a significant number of Scottish Water assets impacted by severe flooding, including access restrictions, power loss and communication failures.[159] Fifteen drinking water systems and more than one hundred waste water systems were affected. Incidents ranged from the flooding of a raw water pumping station supplying 230,000 customers in Aberdeen, to a waste water treatment works in Hawick which was flooded seven times. Scottish Water report that due to proactive contingency planning and rapid and effective response procedures, that these events were managed with minimal inconvenience to their customers. In general the primary cause of unplanned interruptions of the water supply to customer properties is burst water mains.

[158] http://www.watercommission.co.uk/

[159] Scottish Water (2015) *Scottish Water Delivery Plan 2015 to 2021 Update* http://www.scottishwater.co.uk/assets/about%20us/files/key%20publications/swdeliveryplan201521update2016.pdf

Is there a plan?

Scottish Water's business and delivery plans set out how they intend to invest in improving the resilience of their services between 2015-2021. Longer term plans are set out in their 25 year water resources plan.

Scottish Water's role and duties are set out in the Water Industry (Scotland) Act 2002. In 2014 Scottish ministers directed Scottish Water to make provision for climate change adaptation. These directions placed a duty on Scottish Water to improve Scotland's resilience to climate change by:

- continuing to invest in modelling the likely impact of climate change on its assets ; and
- where appropriate investing in managing risks arising from climate change impacts.

The 2014 Directions also placed duties on Scottish Water to fulfil its duties and obligations as set out in the Flood Risk Management (Scotland) Act 2009 and to provide an appropriate level of physical security standards (e.g. the security of energy supply) as agreed with Scottish ministers.

Scottish Water has set out how they will help improve Scotland's resilience to climate change across several published documents. Their business and delivery plans set out investments for the period 2015-21, while longer term aspirations are set out in their 25 year water resources plan. Scottish Water defines resilience as 'the ability of our supply systems to maintain essential services under extreme circumstances such as those caused by extreme weather, climate change (low rainfall or flooding), or unforeseen asset failure.'[160]

Scottish Water assess whether normal supplies can be maintained with no restrictions based on the driest year they would expect over a 40 year period. If supplies can be maintained under such conditions, it implies that there is at most a 2.5% chance of outages occurring in any year.[161] This is Scottish Water's policy level of service. Currently they achieve this level of service for 97% of their customers. They plan to increase their ability to maintain normal water supplies under the driest year they could expect over a 40 year period. By the end of the next business planning cycle in 2027, they aim to achieve this level of service for 100% of their customers. Projections suggest that the proposals in their Water Resources Plan are expected to maintain a healthy supply/demand surplus in Scotland to the 2030s, to retain a 22% (415Ml/d) overall surplus.

However, beyond the 25-year planning period there is a risk of supply-demand deficits. Under a high population growth, high climate change scenario, supply/demand deficits emerge by the 2050s across the central belt of Scotland and by the 2080s Scotland overall would be in deficit.[162]

Are actions taking place?

Significant investment has taken place and continues to be committed by Scottish Water to improve resilience in areas deemed as vulnerable during their assessment process.

[160] Scottish Water (2015) *Scottish Water Business Plan 2015 to 2021*, http://www.scottishwater.co.uk/assets/about%20us/files/strategic%20projections/swbusinessplan201521march2014.pdf

[161] Scottish Water (2015) *Water Resource Plan 2015* (summary report), https://www.scottishwater.co.uk/assets/about%20us/files/key%20publications/wrp2015.pdf

[162] HR Wallingford, Centre for Ecology and Hydrology, British Geological Survey and Amec Foster Wheeler (2015) *CCRA2: Updated Projections for Water Availability for the UK: Final Report for the Adaptation Sub-Committee*. https://www.theccc.org.uk/publication/climate-change-riskassessment-ii-updated-projections-for-water-availability-for-the-uk/

Based on investment in the 2010 to 2015 investment period, Scottish Water improved the supply-demand balance and therefore extended their target level of service to 830,000 (16%) of their customers. This was achieved through reducing leakage, improving efficiency at their Water Treatment Works and the provision of new assets.

Scottish Water has made commitments to ensure that no individual Water Resource Zones will be in supply deficit by 2027 through delivery of the investment already planned between 2015 and 2021 and subsequent investment plans. Alongside this, work is being done to assess the long term impacts of climate change on water availability for the public water supply. This will inform future investment plans, as well as take account of the needs of the environment working closely with SEPA.

Scottish Water undertook a vulnerability assessment of water availability based on climate change scenarios for the 2040s. From this exercise, 52 supply zones were selected for further study to better understand the impact of climate change on water availability in the future. The outcome of this will be used to inform future investment periods as appropriate. Investment is planned for 11 supply zones between 2015 to 2021 and for these, Scottish Water is considering a 1:100 level of service due to their remote location and the limited options for alternative supplies should an extreme event occur.

For 2015 to 2021, Scottish Water will invest £55 million to improve resilience to supplies and improve response to extreme weather events.[163] It plans to spend £4.2 million on assessing the overall resilience of water systems supplying over 15,000 customers and to develop options to improve resilience. A further £1.4 million will be spent on planning for future droughts. Recent assessment of the Ayrshire supply system has identified a need to bolster water supply resilience there.[164] To increase the resilience of the Ayrshire water supply system, Scottish Water announced a £120 million scheme, launched in December 2015, to install 30 miles of new water mains to connect the system in Ayrshire with the Greater Glasgow area's network. This will enable Scottish Water to transfer water from Glasgow to Ayrshire.

Previous investment to improve resilience includes the £250 million, five-year programme to improve river water quality and the natural environment of the River Clyde and its tributaries to help alleviate sewer flooding and deal with the effects of increased rainfall and climate change in the Greater Glasgow area.[165] 12 projects were undertaken between 2010 and 2015 to understand the impacts of climate change on Scottish Water's ability to provide secure and reliable water and sewerage services in the future. A total of 320 projects were undertaken to assess the vulnerability of, and protect where necessary, Scottish Water's assets from the risk of flooding. A further 72 studies were undertaken to understand the risk to homes and businesses of flooding from sewers including five projects in partnership with 11 Local Authorities.

Is progress being made in managing vulnerability?

The numbers of properties affected by unplanned interruptions to water supply has been declining since 2006.

[163] Scottish Water (2014) *Scottish Water Delivery Plan 2015 to 2021*
[164] Scottish Water (2015) *Scottish Water Delivery Plan 2015 to 2021 Update*
[165] Scottish Government et al (2015) *Investing in Scotland's Water Industry: Improvements Delivered in 2010-15*. http://www.gov.scot/Resource/0048/00486833.pdf

Scottish Water have assessed that they can supply around 15% of customers from alternative supplies.[166] This is compared to Anglian Water at 74%, Wessex water at 85% and Yorkshire water who can supply around 99% with alternative supplies. In their current business plan, Scottish Water has set out their intention to carry out investigations which will inform their strategy for extending their water network.

In 2006/07 101,800 properties suffered an unplanned interruption of more than 3 hours and 17,300 properties suffered an unplanned interruption of more than 6 hours.[167] In 2012/13 89,100 (3.5%) customers' properties experienced an unplanned interruption of greater than 3 hours and 12,800 (0.5%) customers' properties experienced an unplanned interruption lasting more than 6 hours.[168] The primary cause of these interruptions was water main bursts. However, Scottish Water does not report interruptions caused by extreme weather separately. Therefore, it is not possible to tell if, over time, resilience to extreme weather is increasing or decreasing.

3.3.7c Ports, airports and ferry services

Is there a plan?	 Amber	Scotland's National Marine Plan (2011) specifies that marine planners 'have sufficient regard for to the impacts of a changing climate and where appropriate provide effective adaptation to its predicted effects'. The updated Scottish Government National Transport Strategy (2016) acknowledges the challenges faced by climate change and makes reference to improving the resilience of transport networks. However, specific adaptation plans do not exist for ports and airports, and the ferry services plan (2013-2022) does not consider the implications of climate change.
Are actions taking place?	 Amber	Edinburgh and Glasgow airports, as well as the Northern Lighthouse Board (NLB), have prepared ARP reports for the UK Government. Reports are also being prepared under the Public Bodies' Duty for Transport Scotland and local transport partnerships such as the highlands and islands transport partnership.
Is progress being made in managing vulnerability?	 Grey	There are no data on whether the steps being taken by ports, airports and ferry operators will be sufficient to avoid an increase in severe weather impacts and disruption to services in future.

Ports, airports and ferry services will be affected by climate change causing extreme weather events (e.g. storms, high tides, flooding, cold weather, heavy ice and snow accumulation) and sea level rise. CCRA1 particularly highlighted the vulnerability of remote and island communities

[166] Scottish Water Business Plan 2015 to 2021 appendices
[167] Water Industry Commission for Scotland (2012) *Reporter Services Scottish Water's OPA Score 2011-12 Reporter's Report.* http://www.watercommission.co.uk/UserFiles/Documents/SW%20AR12%20-%20OPA%20Reporter's%20Report%202012%20(Final%20to%20WICS%20%20SW%20100512).pdf
[168] Scottish Water Business Plan 2015 to 2021 appendices

where ferry services and ports provide vital transport links. As well as providing transport, ports and airports are financially important to the Scottish economy, with ports alone bringing in £1.7bn in 2012. Disruption to service provision from climate-related hazards could, therefore, not only negatively impact individuals reliant on these services, but also Scottish trade.

Is there a plan?

Whilst the overarching 'National Transport Strategy' acknowledges the challenges posed by climate change and the need for a resilient network, recognition of these threats within sector specific-plans is lacking.

Transport Scotland published their latest National Transport Strategy [169]in January this year (2016). This sets out a long term vision for transport in Scotland. It acknowledges the challenges faced by climate change and makes reference to the need to develop transport network resilience to future climate challenges.

For ports, specifically, there are several initiatives that can support adaptation to future climate. Although most ports are self-funded, as commercial or private investments, 'revision orders' can be made by Transport Scotland (under the 1964 Harbours Act) that empower harbour authorities to undertake works, although there is no evidence that these have yet been used for enabling adaptation. The statutory National Marine Plan (2015)[170] also includes a climate change adaptation objective encompassing port planning, stipulating that "Marine planners and decision makers must act in the way best calculated to mitigate, and adapt to, climate change", and that new development, for instance, must have regard to possible future climate conditions.

Transport Scotland's 'Scottish Ferry Services, Ferries Plan (2013 – 2022)[171]', which reviewed the provision of ferry services and sets out strategic guidance for the services for the next 10 years, does not mention or consider the impact of climate change or weather events on the continued provision of ferry services.

There has been no similar review for Scottish airports. However, both Edinburgh and Glasgow airports have produced adaptation reports under the UK Adaptation Reporting Power.

Are actions taking place?

There is evidence of investment and actions taking place to secure the resilience of airports, ports and ferries.

Alongside the National Transport Strategy, the SCCAP includes specific actions relating to climate effects on the transport network; however these are broad and are not specifically for ports, airports and ferry services. These include, for example: research into fog projections, the creation of a central coordinating point for information and data collection relating to climate effects on the transport network, and developing knowledge sharing activities for this sector. Whilst the fog projections research has been carried out, filling a gap in the evidence base, there is little evidence of the information sharing group's work.

[169] Scottish Government (2016) *National Transport Strategy*. http://www.transport.gov.scot/strategy/national-transport-strategy

[170] Scottish Government (2015) *Scotland's National Marine Plan*. http://www.gov.scot/Resource/0047/00475466.pdf

[171] Scottish Ferry Services: Ferries Plan 2013-2022 (2012) http://www.transport.gov.scot/sites/default/files/documents/rrd_reports/uploaded_reports/j254579/j254579.pdf

There is also little evidence available to establish whether the requirement for marine planners to act in a way best suited to adapt to climate change, as set out in the National Marine Plan, has been taken on board (e.g. through development applications) despite this being a statutory requirement since December 2014. Marine Scotland is currently developing a monitoring strategy, which should provide additional evidence for future reporting.

Under the UK Adaptation Reporting Power, the Northern Lighthouse Board (NLB) reported completion of a number of actions relating to future climate resilience. Since their first report in 2011, they have been collecting real-time data on how climate variability is affecting their services and identified that extremes of wind and sea conditions during the winter months were the most prevalent climate change impacts in the North and West of Scotland. They plan to use this data to project future impacts on their assets.

Adaptation reports published by Edinburgh and Glasgow airports include a range of actions together with identified owners. These actions include: reviewing winter operation plans to take into account lessons from the 2009/10 winter and ensuring contingencies consider the future climate; sensitivity tests for airport drainage infrastructure to ensure it is as robust as practicable to future climate extremes; investigating and addressing risks of flooding to existing critical assets; and ensuring appropriate design standards are applied to new buildings to address risks from water ingress and flooding.

Substantial investment has also been made into new measures to improve resilience since the winters of 2010 and 2011. Glasgow airport has invested approximately £3 million in new snow clearing equipment, including two new runway sweepers. Other Scottish airports have also developed their preparation for winter weather. Aberdeen airport, for example, has invested over £1 million on new snow clearing and de-icing equipment. The Highland and Islands Airport Ltd benefits from advanced weather forecasting at all of its airports and new de-icing sprayers are being introduced at smaller airports for resilience purposes.

A Department for Transport resilience review of UK transport networks concluded that ports and airports in Scotland stood up relatively well in the face of a series of extreme weather events in winter 2013/14. [172]

Is progress being made in managing vulnerability?

Indicators of trends in vulnerability are not available.

Information that would enable an evidence-based assessment of the vulnerability of ports, airports and ferry services to extreme weather impacts is not available. Such evidence might include time-series data on the number of disruptions caused by extreme weather events, and the level of investment being made in improving standards of resilience.

[172] Scottish Government (2014) *Transport Resilience Review: A review of the resilience of the transport network to extreme weather events.* https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/335115/transport-resilience-review-web.pdf

3.3.7d Roads and the rail network

Is there a plan?	 Amber	The National Transport Strategy (2016) acknowledges the challenges posed by climate change and makes reference to improving the resilience of transport networks. Network Rail has published a Weather Resilience and Climate Change Adaptation Plan for Scotland, but long-term investment planning does not explicitly account for climate change. Transport Scotland has undertaken numerous studies into key climate risks facing trunk roads and is close to finalising a climate change adaptation and resilience plan.
Are actions taking place?	 Green	Actions are taking place on the rail network to renew and upgrade key civil engineering structures that are vulnerable to extreme weather and to improve real-time weather forecasting. Transport Scotland is developing a central data collection point of climate effects on the transport network.
Is progress being made in managing vulnerability?	 Green	Good progress is being made with renewing and upgrading civil engineering structures on both the rail and trunk road networks. As a result, the resilience of road and rail to extreme weather is likely to be improving.

Weather events can be a cause of significant disruption to the railway network. Recent prolonged periods of rainfall and severe storm events caused flooding at Winchburgh and Dalguise, and earthslips at Loch Treig and on the West Coast Main Line. High winds in December 2013 caused the entire Scotland rail network to shut down.[173] Between 2006 and 2014, the average annual performance cost attributed to weather for the whole network was over £50 million. This accounted for 12% of all delays. [174]

Network Rail identifies high winds and flooding as the two highest priority weather-related risks facing the Scotland network. High winds accounted for 28% of delay costs during 2006-2014. The vast majority of wind-related delay incidents are due to objects being blown on to the line, including trampolines, balloons, polythene sheets and garden sheds. Flooding from heavy rain, rivers and the sea accounted for 24% of delay minutes 2006 to 2014.

Many roads across Scotland were closed during the winter 2015/2016 floods, including major trunk roads such as the A93 and the A83. There were 567 flood incidents recorded on trunk roads and five separate landslides resulting in road closures between January 2014 and March 2015.

[173] Network Rail (2014) *Route Weather Resilience and Climate Change Adaptation Plans*, https://www.networkrail.co.uk/Scotland-Route-WRCCA-Plan.pdf
[174] Ibid.

Is there a plan?

The Scottish Government's updated National Transport Strategy (2016) sets out a long term vision for transport in Scotland.[175] The Strategy acknowledges the challenges faced by climate change and the need to ensure the transport network is resilient to the future climate.

Network Rail is proactively assessing and accounting for climate change in its route management and investment decisions. A Weather Resilience and Climate Change Adaptation Plan for the Scotland route was published in 2014.[176]

Network Rail's management of its assets is moving from an approach based on 'find and fix' to one of 'predict and prevent'. Models have been developed to forecast the amount of investment and volume of renewals required to manage the rail network over the next 40-50 years. These models do not, however, account for projected changes in climate but instead assume that the weather experienced in the future will be similar to what it has been in recent years. In the regulator's assessment (the Office for Rail and Road), Network Rail has not sufficiently embedded climate resilience into specifications for the design of its assets, nor in the standards the company sets for asset maintenance and renewals.[177]

Transport Scotland is currently developing a Climate Change Adaptation and Resilience Plan (CCARP) for the Scottish trunk road network. The CCARP will build on the 2005 Scottish Road Network Climate Change Study and be informed by a number of other studies on weather-related risks to the trunk road network, including a landslide hazard study in 2008 and Met Office modelling of risk from high winds in 2009. The CCARP will identify the most significant current vulnerabilities and where risk might be increased in the future with changing weather patterns. The risk assessment will support future investment decisions. Work on the CCARP is well advanced, with completion expected later in 2016.

Are actions taking place?

– Rail network

Actions are taking place and additional investment is planned for projects to boost the resilience of the rail network up to 2019.

Over £1 billion will be spent between 2014 and 2019 on renewing the ageing rail network structures in Scotland, including route enhancements to the Aberdeen to Inverness route, re-establishing the borders railway and the Edinburgh to Glasgow Improvement Programme. [178]There are 138 coastal and estuarine defence assets in the Scotland route.[179] This is a significant proportion of the UK total as many lines were built along low-lying coastal areas to

[175] http://www.transport.gov.scot/system/files/documents/reports/Main%20doc%20-%20Transport%20Scotland%20-%20National%20Transport%20Strategy%20-%20January%202016%20-%20final%20online.pdf

[176] Network Rail (2015) *Climate Change Adaptation Report*,http://www.networkrail.co.uk/publications/weather-and-climate-change-resilience/

[177] ORR concluded that Network Rail should do more to embed climate resilience into its specifications for new overhead lines, track and structures and be more proactive in identifying interventions that would improve resilience to climate change. See ORR (2013) Final Determination of Network Rail's outputs and funding for 2014-19 (pp 276-277).

[178] Network Rail (2014) *Delivering a better railway for Scotland. Our plans for 2014-2019.*

[179] Network Rail (2014) *Route Weather Resilience and Climate Change Adaptation Plan,* https://www.networkrail.co.uk/Scotland-Route-WRCCA-Plan.pdf

avoid upland terrain. Nearly 6 km of coastal defence assets are due to be renewed during the 2014 to 2019 period.

As well as ongoing renewals to key civil engineering structures, Network Rail is also implementing a Weather Resilience and Climate Change (WRCC) programme. The WRCC programme is one of the Company's top 15 business change projects in the current price control period (2014-2019). Key outcomes of the WRCC programme in Scotland include:

- Investment of £10 million to address high risk trees and mitigate the impact of both extreme winds and adhesion issues.
- Installation of up to 7,000 points heat insulation and covers.
- Forensic investigation of 89 of the 261 earthworks failures in 2012/13 and 2013/14 and establishment of an earthworks remote condition monitoring pilot.
- Aerial surveys of infrastructure using the Light Detecting and Ranging (LIDAR) technique.
- Significant improvements to real-time weather forecasting through installing 102 weather stations.

– Road networks

Actions noted in the SCCAP include collecting real-time information about the impact of weather events that are taking place. Real-time traffic information is collected relating to incidents, including weather events, on the trunk road network.[180]

Transport Scotland's model for future investment and indicative work plan predicts a total budget of £666 million needed to maintain trunk road carriageways at current structural condition over the next 10 years (2016- 2016).[181] This investment, which will include resurfacing 80% of the network, provides an opportunity to ensure that strategic roads are resilient to a changing climate and to address drainage issues. However, Transport Scotland does not provide any breakdown of planned expenditure on resilience measures, such as drainage.[182]

Is progress being made in managing vulnerability?

– Rail networks

Progress is being made in completing renewals of critical structures, with a decreasing trend in asset failures.

Network Rail is making good progress with delivering renewals for most civil engineering structures on the Scotland route, over-delivering against its targets for earthworks and culverts and on track with tunnels and coastal defences. However, delivery is well below forecast for renewals of retaining walls and slightly under for bridges (Figure 3.7). The regulator's most recent report (July 2016) finds that the volume of work completed in all the major areas is ahead

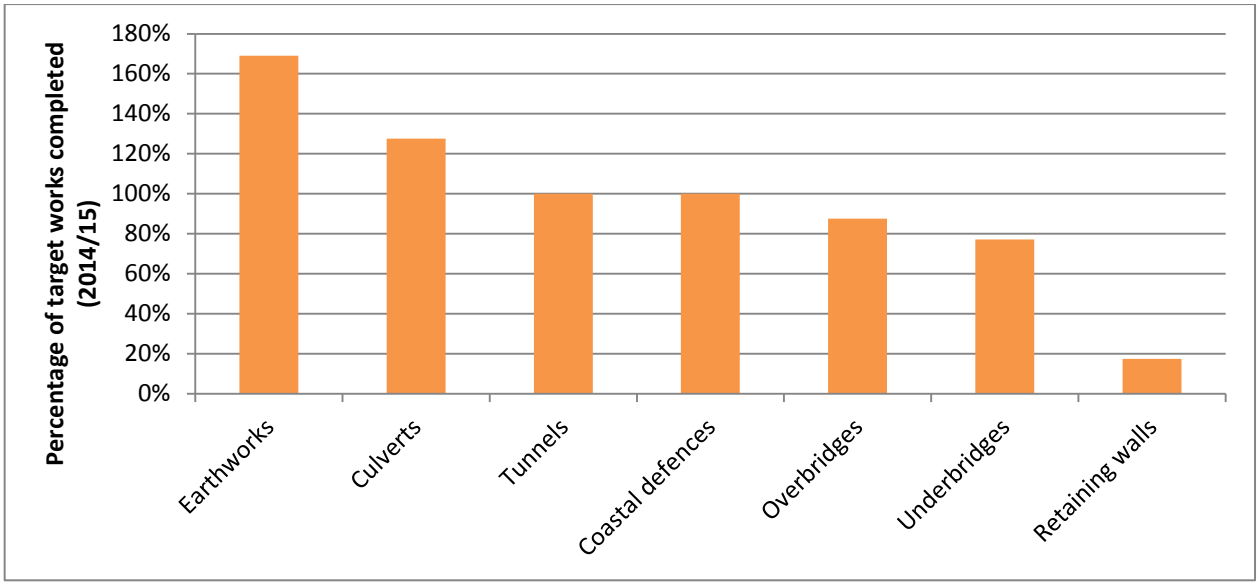
[180] https://trafficscotland.org/about/

[181] Transport Scotland (2016) *Road Asset Management Plan for Scottish Trunk Roads,* http://www.transport.gov.scot/sites/default/files/documents/rrd_reports/uploaded_reports/j408891/j408891.pdf

[182] However, Transport Scotland does not provide any breakdown of planned expenditure on resilience measures, such as drainage.

of or on plan and that Network Rail has successfully reduced the incidence of service-affecting asset failures in 2015-16, continuing the long-term downward trend.[183]

Figure 3.7: Progress with renewing route rail network structures in 2014/15



Source: Network Rail Annual Return 2015 (p150).
Notes: The lack of progress with renewals of retaining walls is due to works associated with the Langbank site, which is expected to be completed later in CP5 following the Coastal and Estuarial works.

– Road networks

The condition of trunk roads has improved steadily between 2010 -2015, with fewer roads classed as 'amber' but no improvement in the number of 'red' roads.

The condition of trunk roads has improved since 2010 with a lower proportion categorised as amber (down from 46% to 37%).[184] However, the percentage of roads classed as 'red' roads, meaning deterioration to the point at which repairs to prolong its future life should be undertaken, has remained at 8%. Transport Scotland expenditure on maintenance of the trunk road network (including winter maintenance) has not significantly changed in recent years. In 2014/2015 and 2013/2014 £241million was spent, compared to £271million in 2012/13 and £256million in 2011/12. [185]

[183] ORR Network Rail Monitor Scotland, Quarters 3-4 of Year 2 of CP5 (Oct 2015-March 2016). ORR notes that the Composite Reliability Index (CRI) was 13%, well above the target of 9.7%.
[184] Transport Scotland (2014) *Scottish Transport Statistics*, http://www.transport.gov.scot/report/scottish-transport-statistics-no-34-datasets-8914
[185] Ibid.

3.3.7e Digital infrastructure

Is there a plan?	 Amber	The Communications Act (2003) includes a requirement for telephony and data services to be maintained even in extreme weather. Communications and data service providers report annually to the Cabinet Office as part of sector resilience planning. However there is no overall plan to maintain the resilience of the digital infrastructure sector.
Are actions taking place?	 Grey	There are no specific actions mentioned in the SCCAP. However, Tech UK is expected to publish shortly an ARP report on behalf of the ICT sector (though this is overdue from 2015). Openreach are due to also report later in 2016.
Is progress being made in managing vulnerability?	 Grey	There is very little information at present on the exposure of data and telecoms facilities and services to extreme weather impacts. The forthcoming ARP reports from the sector will hopefully provide useful insights.

CCRA1 highlighted that around 80% of businesses in Scotland are dependent on ICT and that any disruption would have immediate consequences. This would predominantly affect small businesses due to their dependence on a single digital link. The primary risk highlighted was the lack of knowledge of the risks to this sector.

Is there a plan?

Adaptation planning in the digital sector remains at an early stage.

76% of households in Scotland have access to the internet[186] with 72.5% of Scotland's geography covered by mobile signal.[187] The Scottish Government's aim is to be a world leading digital nation by 2020. Their Digital Future strategy[188] outlines the steps that are required to ensure Scotland is well placed to take full advantage of all the economic, social and environmental opportunities offered by the digital age. The strategy, however, makes no mention of resilience of, or risks to, digital infrastructure from climate change. Adaptation planning in the digital sector however remains at an early stage.

The requirement of service providers to take appropriate action to maintain the provision of services even under extreme conditions is mandated under the Communications Act 2003. Ofcom, the communications regulator, is responsible for reporting to DMCS every three years on the performance of communications network and service infrastructure, including outages. In 2010 Ofcom itself reported on the impacts of climate change on its functions, however no further adaptation reports from the sector have since been published.

[186] Scottish Government (2014) *Digital Participation A National Framework for Local Action* (p12). http://www.gov.scot/Resource/0044/00448804.pdf

[187] Mobile Performance and coverage in Scotland, 2013 Page 27, http://www.gov.scot/Resource/0043/00433910.pdf

[188] http://www.gov.scot/Publications/2011/03/04162416/0

Are actions taking place?

There is little evidence of action taking place to improve the resilience of the digital sector.

In December 2013, storm force winds, rain, snow and extreme storm surges resulted in flood damage to the BT Openreach network, both above and below ground. As a result there was a major increase in faults across the affected areas (highlands and islands, eastern Scotland, south west Scotland and west central Scotland).[189]

The SCCAP contains no specific actions relating to ICT, despite the sector being recognised by the Scottish Government as key to economic development. This was because the Scottish Government considered the risks to the sector as too uncertain. As a result there are no plans relating to overall resilience of the digital sector. The communications sector does however, report annually to the Cabinet office regarding a range of threats as part of the national risk assessment.

Reports under the UK Adaptation Reporting Power are overdue from Tech UK and BT Openreach, originally due for publication in 2015.

Is progress made in managing vulnerability?

There is some evidence that service providers are managing extreme weather impacts, but no data exists on the current level of resilience and how this is changing over time.

The sector should be inherently resilient, with rapid renewal of equipment and inbuilt redundancy as a result of distributed network and data technologies – though networks in remote areas benefit less from redundancy. The latest report from Ofcom in 2014[190] says that during winter 2013-2014 providers were well prepared for severe weather and succeeded in minimising the impact on consumers.

Whilst there is a lack of information for this sector, some information is gathered for the Ofcom reporting that could be used to develop trend data, such as the number of incidents reported to Ofcom. Other additional information that would be helpful for the measurement in this sector includes the number of data centres exposed to a risk of flooding.

[189] https://recombu.com/digital/article/british-storms-broadband-scotland-yorkshire-humberside_M12601.html#
[190] http://stakeholders.ofcom.org.uk/binaries/research/infrastructure/2014/infrastructure-14.pdf

3.3.8 Infrastructure interdependencies

Is there a plan?	 Green	The Critical National Infrastructure Plan (2011) sets a strategic objective to 'develop a detailed understanding of the interdependencies and impact of loss issues for Scotland as a whole'. Resilience reviews are undertaken by the Cabinet Office.
Are actions taking place?	 Amber	Regional Resilience Partnerships and an UK-wide Infrastructure Operators Adaptation Forum meet to develop and share best practice across infrastructure sectors and to discuss lessons.
Is progress being made in managing vulnerability?	 Grey	There is no evidence that specific measures have been taken across infrastructure sectors to improve 'system of systems' resilience. Whilst individual sectors report to the Cabinet Office as part of sector resilience planning, the recent Cabinet Office reviews looking at inter-dependencies have focused on England alone. There is no evidence that similar reviews have been undertaken in Scotland.

Infrastructure networks do not operate in isolation. In particular, networks are reliant on electricity and ICT to be able to maintain services. Losses in electricity are often overcome by back-up diesel generators, but if outages continue power crises can quickly become fuel crises.

Is there a plan?

A strategic objective to develop a detailed understanding of the interdependencies of infrastructure is included within the Critical National infrastructure plan.

The Critical National Infrastructure plan[191] includes an objective to prepare a detailed understanding of interdependencies and impact of loss issues for Scotland as a whole and for each of the Strategic Coordinating Group areas. Whilst organisations that are responsible for national infrastructure may have resilience plans in place it is unclear whether this detailed understanding has been developed or led to actions being taken on the ground.

Are actions taking place?

At a UK level there are two working groups that meet regularly to discuss common issues including climate change adaptation.

Whilst the SCCAP does not include reference to any policies and proposals in this area, there are actions taking place:

The UK Infrastructure Operators Adaptation Forum (IOAF) meets quarterly to discuss progress in adaptation, primarily in the form of round-table updates and presentations. Transport Scotland

[191] Scottish Government (2011) *Secure and Resilience: A strategic framework for critical national infrastructure in Scotland,* http://www.gov.scot/Resource/Doc/346469/0115308.pdf

and Adaptation Scotland are both members of this forum. However there is no evidence as to whether such discussions have led to additional or more effective action being taken.

Is progress being made in managing vulnerability?

There is no current evidence as to whether actions have resulted in changes to the vulnerability associated with infrastructure independencies.

Failures caused by interdependencies are not systematically recorded.

3.4 Conclusions on SCCAP objectives

SCCAP Objective	Commentary
B1-Understand the effects of climate change and their impacts on buildings and infrastructure networks.	There are 19 policies and proposals that support this objective. These include overarching policies that tackle flood risk, such as the development of flood risk management strategies and plans and river basin management plans. As well as research to be undertaken under the National Transport Strategy on transport infrastructure. Scottish Government has identified that current building standards are suitable for new buildings however that additional research is needed on impacts of surface water flooding and guidance is available for historic buildings. The policies and proposals under this objective appear to cover most of the areas where climate change effects need to be understood. Five of the policies and proposals were reported to be 'completed', 13 as 'on track' and two reported as 'revised'. These latter however were that action is now taking place under the research programme of the transport strategy rather than not being carried out.
B2-Provide the knowledge, skills, and tools to manage climate change impacts on buildings and infrastructure.	There are 22 policies and proposals that support this objective. Four were reported to be 'completed', 12 as 'on track' and two were 'revised'. The policy area dropped was to implement a Scottish Maritime Transport Strategy. Some of the policies focus on providing guidance and tools for decision makers and local deliverers, however in other cases it is unclear how the policies build capacity other than continuing to build the evidence base.
B3-Increase the resilience of buildings and infrastructure networks to sustain and enhance the benefits and services provided.	There are 17 policies and proposals that support this objective. Of these, three were reported to be 'completed', 15 as 'on track' and none were 'revised or delayed'. This section predominantly summaries polices that are already taking place to support the future viability of services provided by the natural environment. Some of the action is about embedding climate change into overarching policies such as the Common Fisheries Policy and others tackle direct known impacts of climate change, such as developing containment standards for fish farms to decrease over-topping.

Chapter 4: Society

Key messages

Adaptation plans are in place and there are multiple actions underway in Scotland to address the risks to society from flooding, storms, air pollution and pathogens. Evidence suggests that Scottish businesses are also taking action to increase their resilience to the impacts of climate change. However, there is little monitoring and evaluation of what impact these actions may have on vulnerability to climate-related hazards over time.

Plans should be strengthened to consider the current and future risks to people from heat, cold, and UV radiation, and the adaptation action that will be needed. Better understanding is also needed of the capability of the emergency planning system and the capacity for communities to recover after an extreme event. Businesses are able to access guidance and tools to help them adapt, but their take-up and impact is not known.

This chapter explores the extent to which progress is being made to adapt to climate change and to protect the health and wellbeing of the population. In addition, the chapter assess the extent to which businesses are aware of climate change risks and planning to seize the opportunities that may arise.

Overview of progress

Adaptation priority	Is there a plan?	Are actions taking place?	Is progress being made in managing vulnerability?
Health and social care services	Amber	Green	Grey
Emergency planning and response	Green	Green	Grey
Recovery from extreme weather events	Amber	Amber	Grey
Resilience of the population to changes in temperature	Amber	Green	Amber
Resilience of people to pathogens, air pollution, UV radiation	Amber	Green	Grey
Public understanding of climate related risks	Green	Green	Grey

Key messages

Business impacts from extreme weather	 Amber	 Green	 Amber
Business opportunities from climate change	 Amber	 Amber	 Amber
Supply chain disruptions	 Amber	 Amber	 Amber
Water demand by industry	 Amber	 Green	 Grey

Summary of progress

Detailed plans are in place across a number of health and wellbeing functions in Scotland to assess and manage the risks from climate change.

- The Sustainable Development Strategy for Scotland and the public bodies reporting power together require all NHS bodies to produce individual climate change actions plans. A climate change risk assessment has been carried out for the whole of the NHS Scotland estate.
- A national resilience centre has been set up in Scotland, with the aim of ensuring that communities across Scotland are prepared for natural hazards.
- Regular monitoring and early warning systems are used for detecting new pathogens and changes in air quality.

There is a specific SCCAP objective and actions on increasing public awareness of extreme weather, climate change and its impacts, including:

- delivery of flood warnings and wider advice on informing the public such as through the 'Preparing Scotland' guidance;
- the 'Ready for Emergencies' resilience resource for schools - an online tool for children to inform them about the impacts of severe weather and flooding;
- the 'Ready for Winter' website, giving advice on preparing for cold weather;
- Age UK guidance and the 'NHS inform' portal that includes information on heat stress; and
- web-based advice on air pollution, UV exposure, food safety and food hygiene.

Across the health and business sectors however, very little information is collected to assess how these and other actions are affecting vulnerability, and for some risks plans have not yet been developed.

Key messages

- Heat currently contributes to fewer deaths than from cold but the number of heat-related deaths is expected to increase. There may be between 70 – 280 heat-related deaths per year in Scotland by the 2050s in the absence of adaptation (compared to around 40 deaths per year at present). The future effects of heat on health and wellbeing more generally have not been estimated. There are currently no plans in place that aim to prevent heat-related risks to people during periods of hot weather.
- By the 2050s, in the absence of action, cold weather is still projected to contribute to around 1,800 – 2,900 deaths per year even though winters on average are expected to become milder, compared to around 2,600 – 3,900 deaths per year at present.[192] The Scottish Government does not have a plan to reduce the number of cold-related deaths, but does have an overarching goal to eliminate fuel poverty by the end of 2016, which would also have knock-on effects on exposure of the population to cold. Whilst the proportion of people living in fuel poverty and extreme fuel poverty has decreased from 49.4% in 2011 to 44.4% in 2014, significant vulnerability remains and this ambitious goal will not be met.
- Emergency responders have responsibility for plans to support recovery following an extreme event. There is limited data and it is difficult to collect evidence regarding the impacts of extreme weather on long-term health, and the length of time it takes people and communities to recover. In addition to the lack of data on impacts, no data are available on the current capability of the emergency planning system in Scotland. Therefore it is not clear what steps might be necessary to prepare for an expected increase in extreme weather events. Plans are in place to address the current level of risk to people from vector-borne and food-borne diseases, but it is not clear whether resources are being targeted towards those pathogens likely to present the most significant risks to public health in the future. Research is being carried out to assess the impacts of climate change on risks for food-borne, but not vector-borne, diseases.
- Businesses are able to access tools and guidance to help them adapt to climate change. However, it is unknown how widely these are being used or what their impact has been. There is no plan in Scotland to develop a better understanding of opportunities to businesses from climate change, for example in the tourism industry.

Recommendations for further progress:

RECOMMENDATION 14: The Scottish Government should, before the next SCCAP, assess the current level of capability within the emergency response system to deal with extreme weather events and take further steps as necessary to prepare for climate change.

RECOMMENDATION 15: The Scottish Government should, before the next SCCAP, co-ordinate with local authorities to assess the impact on people, businesses and communities arising from flood events, including persistent health and wellbeing effects, and consider what further steps might be taken to help communities recover from extreme weather events more quickly.

[192] ASC (2016) *UK Climate Change Risk Assessment Evidence Report: Chapter 5, People and the Built Environment*.

Key messages

RECOMMENDATION 16: The Scottish Government should, before the next SCCAP, review policies that address the current and long-term risks from both heat and extreme cold.

RECOMMENDATION 17: Health Protection Scotland should, before the next SCCAP, carry out new research into the current and future risks to the population from heat and UV radiation, and consider proportionate responses to the risk.

RECOMMENDATION 18: Health Protection Scotland should, before the next SCCAP, assess the changing risks to people from vector-borne diseases, making use of the second UK Climate Change Risk Assessment Evidence Report. This should consider priority areas for future monitoring and surveillance and whether current resources are aligned with the areas of greatest current and future risk.

RECOMMENDATION 19: The Scottish Government should, before the next SCCAP, review the take-up and impact of guidance and tools for organisations, businesses and communities provided by Adaptation Scotland.

RECOMMENDATION 20: The Scottish Government should, before the next SCCAP, develop policies to encourage businesses in high risk areas to become more flood resilient and report on the actions being taken by businesses as a result.

RECOMMENDATION 21: The Scottish Government should include actions within the next SCCAP that will help businesses in Scotland understand and exploit the economic opportunities arising from climate change.

RECOMMENDATION 22: The Scottish Environment Protection Agency should begin, by the end of 2017, to publish annual data on water abstraction by industry (separately from agriculture and energy generation) so vulnerabilities can be assessed and managed over time.

RECOMMENDATION 23: The Scottish Government should, before the next SCCAP, set out how the 'Scotland the Hydro Nation' programme incorporates SEPA's national water scarcity plan.

4.1 Risks to, and opportunities for, health, wellbeing and businesses in Scotland from climate change

Climate change has the potential to impact on health and wellbeing, the functioning of businesses, and the emergency planning, health and social care system in Scotland.

Climate change is likely to impact people through direct risks such as injury from extreme weather events and indirect risks such impacts on mental health after a flood event. Adapting to the future climate will also be important for the health and social care system, to enable it to continue to provide routine and emergency services.

Climate change is also likely to increase pressure on the emergency response system through more frequent and intense episodes of extreme weather. Therefore, emergency responders need to plan for both current and future potential climate impacts.

Climate change will also pose risks and opportunities for other aspects of Scottish society, most notably its businesses and industries. The Scottish Government's 2015 Economic Strategy does not make reference to preparing for the impacts of climate change and there are no relevant

policies and proposals in the SCCAP. The 2011 Scottish Climate Change Adaptation Framework: Business and Industry Sector Action Plan[193] provided a good framework for action in this area; however this was not built upon in the SCCAP.

The first CCRA, published in 2012, identified a number of the risks and opportunities to businesses, people and public sector services in Scotland, including:

- **Health impacts from flooding:** CCRA1 projected an increase in the number of people suffering from mental health impacts from flooding by the 2080s, but there is low confidence in this estimate as there is no baseline information available. The projected increase in deaths or injuries due to flooding remained small in the future. Pressures on the emergency services were projected to increase as a result of increased flooding, wildfires and other weather related events.
- **Heat related deaths:** Higher temperatures were projected to result in an additional 100 [uncertainty range of 25 to 285] heat-related deaths per year in the 2050s, rising to approximately 200 [50 to 660] by the 2080s. Cold-related deaths were projected to decrease by approximately 550-890 [200 to 1,570] by the 2050s, and then rise to approximately 800-1,300 [range 330 to 2,330] by the 2080s (not including population growth). It remains unclear what the baseline values are in Scotland for heat- and cold-related deaths.
- **Increased algal and fungal growth:** Warmer, wetter winters were projected to lead to increased algal and fungal growth in buildings with consequential effects on those vulnerable to asthma and other respiratory diseases.
- **Isolated communities:** CCRA1 also projected an increased risk to isolated rural communities and businesses from extreme weather events, as they are often reliant on limited transport links and power and fuel supplies.
- **Flood risks to businesses:** The potential for increases in flooding was noted as a major risk to business, but no data were available specifically for Scotland. However, the value of mortgages at risk in the UK due to insurance becoming unaffordable or unavailable, was projected to be in the order of £100 million to £800 million by the 2050s.
- **Tourism:** The effects of climate change on businesses and the natural environment were thought to have potentially significant effects on tourism, with both positive and negative outcomes. CCRA1 included a projected reduction in beach area due to erosion by the 2080s of between 3% and 12%.
- **Opportunities for fishing:** Warming seas were thought likely to lead to shifts in the distribution of commonly fished species, with some species moving north. This would affect the fishing industry, although there would also be new opportunities as other species move into Scottish waters from the south.

In July 2016, the ASC published an Evidence Report to inform the second CCRA (CCRA2). The Evidence Report includes a national summary for Scotland, which covered the above risks and opportunities from CCRA1 but also included a new method for assessing risks by business function. Further work was also done to assess flood risks to people, and new opportunities were included such as the potential for more outdoor activity and active travel due to warmer weather.

[193] Scottish Government (2010) *Business and Industry Sector Action Plan.* http://www.gov.scot/Resource/Doc/175776/0114872.pdf

4.2 SCCAP objectives for the Society theme

The SCCAP contains a high level outcome for this theme: "A Scotland with strong, healthy, resilient communities which are well informed and prepared for a changing climate". There are three objectives to meet this outcome:

- **Objective S1**: Understand the effects of climate change and their impacts on people, homes and communities.
- **Objective S2**: Increase the awareness of the impacts of climate change to enable people to adapt to future extreme weather events.
- **Objective S3**: Support our health services and emergency responders to enable them to respond effectively to the increased pressures associated with climate change.

The SCCAP objectives describe important high-level principles and processes for adaptation. However, as noted in Chapter 1, the SCCAP objectives tend to describe processes rather than outcomes and do not state goals against which substantive progress can be measured. Even where stated objectives are being achieved, vulnerability to climate change impacts may be increasing.

To enable a robust assessment, the ASC has identified a set of adaptation priorities for each of the SCCAP themes. The progress being made in respect of each of these adaptation priorities is reviewed in Section 4.3. Progress with each of the three objectives is also summarised in Section 4.4.

Figure 4.1 presents the climate hazards, contextual factors and adaptation priorities that are relevant to the Society theme, together with a summary of the relevant actions listed in the SCCAP.

Figure 4.1: Climate hazards, contextual factors and adaptation priorities for the society theme

Climate hazards	Contextual factors	Adaptation priorities	Summary of relevant SCCAP policies and proposals
Higher temperatures Increased winter rainfall More heavy rainfall days Changes in ocean water temperature and quality Sea level changes	Population growth Other demographic change Economic growth Remote communities Consumer preferences	Health and social care services	• Develop property and asset management plans for NHS Boards • NHS procurement to consider design of accommodation for ICT • Build on Health Protection Scotland scoping report to prioritise action • Consider climate impacts on chronic diseases
		Emergency planning and response	• Assess operational preparedness and response capability to severe weather events • Deliver flood warning dissemination programme and consideration of awareness raising of flooding by emergency services • Delivery 'Ready for Emergencies' resilience in schools • Improve regional resilience partnerships risk assessment guidance • Assess impacts of environmental factors on delivery of police services
		Recovery from extreme weather events	• Continue development of understanding of impacts of climate change on vulnerable communities • Develop psychosocial disaster recovery guidance • Promote community resilience guidance
		Resilience of the population to changes in temperature	• Eradicate fuel poverty as far as practically possible • Improve public information and access to guidance on heat waves
		Resilience of people to pathogens, air pollution and UV radiation	• Food Standards Scotland (FSS) research into food-borne disease related pathogens, and education and awareness raising about food safety • Develop VTEC/E.Coli Action plan • Assessment of new, emerging or re-emerging disease epidemiology
		Public understanding of climate risks	• Continuation of work by Adaptation Scotland • Continue to develop Ready Scotland website • SEPA flood risk awareness raising activities • Increase flood risk and resilience awareness in schools • Support Scottish flood forum and continue flood forecasting and flood warning dissemination
		Business impacts from extreme weather	No policies and proposals referenced in the SCCAP, however action is taking place that is referred to in this report
		Business opportunities from climate change	
		Supply chain disruptions	• Market driven supply chain project
		Water demand by industry	• Implement Scottish Water Resource Management Plan

4.3 Progress being made

This section evaluates the extent to which the actions and policies in the SCCAP and elsewhere are addressing the identified climate risks, following the method outlined in Chapter 1. Further details and the underlying evidence supporting the analysis of each of the adaptation priorities can be found in Annex C, available on the CCC's website.

4.3.1 Health and social care services

Is there a plan?	 Amber	The Sustainable Development Strategy for NHS Scotland requires each NHS body to produce action plans that consider the effects of climate change on facilities. The plan does not cover service provision or staff, though business continuity plans cover these issues. There are no plans that consider improving the resilience of social care provision delivered by local authorities.
Are actions taking place?	 Green	Health and social care bodies of Scotland report on what adaptation actions they are taking through the public bodies' duties reporting requirements. An impact assessment was carried out for the whole of the NHS Scotland estate in 2015, including specific assessments for each NHS property.
Is progress being made in managing vulnerability?	 Grey	There is no data available on the impact of the steps taken to date to reduce the vulnerability of the health and social care sector to climate change. Some baseline information is available that shows, for example, that at present 350 out of 6,240 hospitals, surgeries, care homes and emergency service assets are located in areas at 1:200 or higher risk of flooding.

The health and social care system in Scotland will be affected by climate change in two principal ways:

- Direct impacts on assets and facilities from extreme weather; for example, heatwaves, flooding of health care facilities, and disruption to patient transportation due to weather extremes such as flooding.
- Indirect impacts of changing demand on services from people affected by climate hazards; for example, increases in temperature leading to premature deaths and increases in fungal and algae growth in buildings potentially exacerbating respiratory conditions.

Health and social care in Scotland is delivered through NHS Scotland. Healthcare is provided through 14 local Health Boards and seven national special Health Boards. The Public Health (Scotland) Act 2008 placed duties jointly on health boards and local authorities to have a responsibility to protect public health. Social care is coordinated jointly through the local Health Boards and local authorities through 31 Health and Social Care Partnerships (HSCPs). Health Protection Scotland is a division of NHS National Services Scotland and provides advice, support and information to health professionals, national and local government, the general public and a number of other bodies that play a part in protecting health.

Is there a plan?

There are requirements for NHS Scotland bodies to consider the impacts of climate change on their facilities. Social care provision through local authorities, and impacts on service provision, are not included.

The Sustainable Development Strategy for NHS Scotland (2012) requires each NHS Scotland body to produce a sustainable development action plan. The plans must include an assessment of the likely impacts of climate change on NHS facilities, which each local health board and special board has carried out. It also advocates including adaptation in building design. The strategy does not include the need to assess the risks to service delivery from extreme weather, but business continuity plans do cover this. Social care facilities and service provision that is delivered through local authorities is not covered under the plan.

A Health and Wellbeing Sector Action Plan was also developed in 2011.[194] This plan includes a number of adaptation actions for the health and social care sector. However, it is not clear if the plan is being used by the current Government and how it links to the more recent sustainable development action plans. The Sector Action Plan was not mentioned in the SCCAP.

More recently, the Scottish Government has published a '2020 Vision for the health care system' with a route map to implement this vision. However, these documents do not mention the risks from climate change.

Are actions taking place?

An assessment of the risks from climate change to the NHS Scotland estate has been completed.

A climate change risk assessment has been carried out for the whole of the NHS Scotland estate.[195] Each local and special health board have also produced a climate change impact assessment that includes current and future risks related to patient demand, vulnerable communities and business continuity. The assessments include risks related to heat, cold, flooding and other types of extreme weather. Individual assessments have also been made for specific risks such as fluvial flooding for hospitals.

The enhanced public bodies reporting powers requires all of Scotland's national health boards and the Scottish social services council to report annually on any adaptation actions they are undertaking.

Is progress being made in managing vulnerability?

There are significant evidence gaps concerning the resilience of the health and social care sector to extreme weather and incremental changes in the climate.

For example, flood risk assessments for health and social care assets highlight that of the 202 hospitals in Scotland there are currently six (3%) hospitals in areas at risk of coastal flooding, 21 (10%) in areas at fluvial flood risk and 116 (57%) in areas at risk of surface water flooding. However, there is no monitoring mechanism to obtain time series showing whether this number is increasing or decreasing over time. In addition, little is known about the extent to which impact assessments and adaptation plans are being implemented, and what level of protection against extreme weather is being delivered as a result.

[194] http://www.gov.scot/Topics/Environment/climatechange/scotlands-action/adaptation/AdaptationFramework/SAP/Health

[195] JBA for NHS Scotland (2015) *Climate Change Impact Assessment for the NHS Scotland Estate*

4.3.2 Emergency planning and response

Is there a plan?	 Green	Part 1 of the 'Civil Contingencies Act 2004 (Contingency Planning) (Scotland) Regulations 2005' sets roles and responsibilities for emergency preparedness. Part 2 of the Act provides emergency powers that can be used in case of an extreme, national-level emergency.
Are actions taking place?	 Green	A number of activities specifically focusing on raising awareness to extreme weather are ongoing and include flood warning advice and capacity building in communities. A National Centre for Resilience was set up in April 2016 with the aim of ensuring communities across the country are adequately prepared for natural hazards.
Is progress being made in managing vulnerability?	 Grey	No data exists to assess the level of current capability of the emergency planning system, and there is a lack of evidence on what resources are necessary to be able to cope with current and future extreme weather conditions.

Demands on the emergency services in Scotland are likely to increase in the future with climate change and population growth. In general, it is difficult to project precise future changes in extreme weather and therefore what level of action might be needed now to address future risks. Some estimates are available; for example CCRA1 highlighted that flood-related demands on the emergency services in Scotland could double by the 2050s. However, the level of confidence in these estimates is fairly low, and this section therefore focusses on how the current capability of the emergency planning system compares to the current level of risk.

Is there a plan?

The UK National Risk Register includes an assessment of the current risks from extreme weather events.

The Civil Contingencies Act (2004) requires the UK Government to carry out a National Risk Assessment (NRA) of possible civil emergencies across the UK. These risks appear within a public-facing National Risk Register (NRR), and include non-weather related risks such as terrorist attacks, as well as weather-related events. The register currently includes weather-related risks from flooding, storms and gales, low temperatures and heavy snow, wildfire, heatwaves and drought. In Scotland, Part 1 of the Civil Contingencies Act 2004 (Contingency planning) (Scotland) Regulations 2005 describes the roles and responsibilities of organisations from national to local authority level in responding to emergencies. In instances where an emergency requires central government involvement, relevant lead departments have been identified.

At a local level, individual responders have plans specific to their functions in the event of an emergency. Responders work together as part of three regional resilience partnerships (RRPs). There are also strategic plans within each of the RRPs.

Are actions taking place?

The SCCAP focusses on actions to increase public awareness and training for those responding to extreme weather events.

These actions include, but are not limited to:

- delivery of flood warning advice and dissemination;
- development of resources to support capacity building in communities and emergency response organisations;
- publication of 'Preparing Scotland: Warning and Informing' guidance on how to inform and work with the public;
- specialist training for different responder organisations, including about future effects of climate change.

The 'Ready Scotland' website provides a range of information and guidance to the public and organisations on preparing for (and recovering from) emergencies.[196] Among other things, it provides guidance to organisations on how to plan and undertake emergency test exercises.

A National Centre for Resilience was set up in April 2016 to support emergency planning. The aims and proposed operations for the Centre are still being developed.

Is progress being made in managing vulnerability?

It is not possible to assess how vulnerability to weather-related emergencies is changing because it is not currently clear what the current level of capability of the emergency planning system is, and what is needed to cope with current or future extreme weather.

This information is needed to understand the extent to which the current system will be able to cope with changes in the frequency and intensity of extreme weather events with climate change.

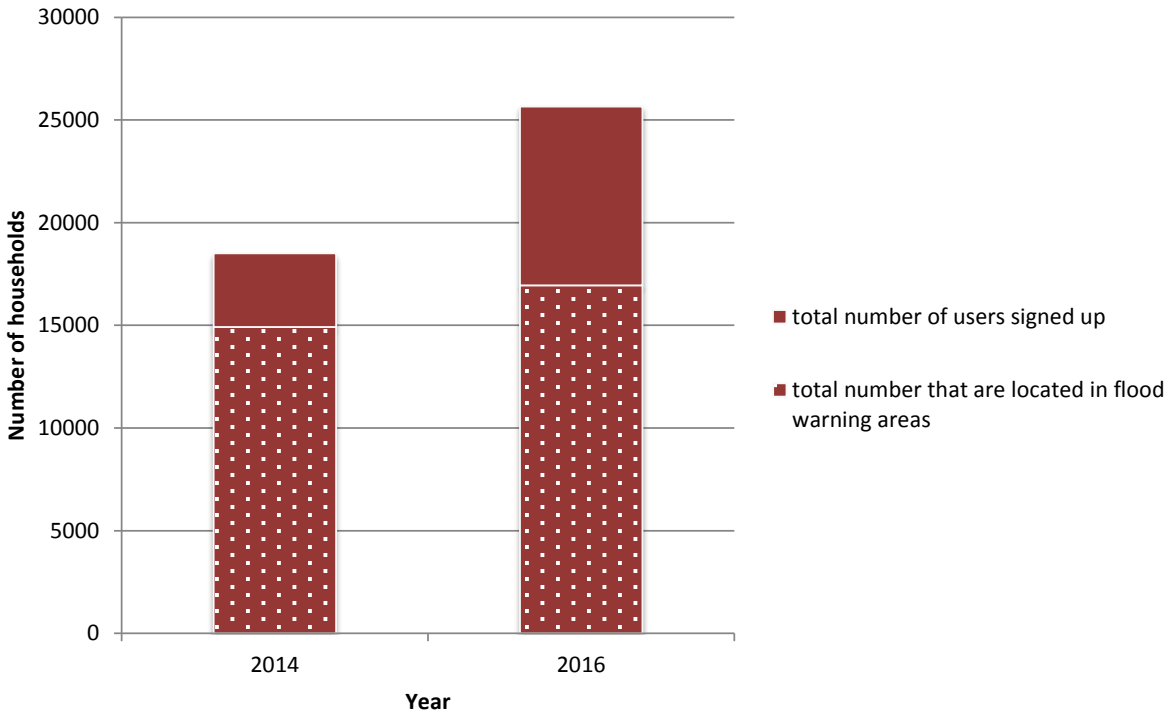
A limited amount of information is available through relevant indicators, for example, the number of incidents the Fire and Rescue services have attended in relation to flooding. In 2009/10 there were 2,037 incidents, which equated to 17% of the total non-fire call outs, compared to 11% in 2013/14.[197] This indicator measures past impact rather than vulnerability, and as such will fluctuate year by year depending on the level of flooding. A very long time series would be needed before any conclusions could be drawn, though information of this kind is useful for understanding the level of burden on the fire and rescue services from flood-related incidents.

Some data are also available on the uptake of flood warnings and guidance. In 2014, 18,501 households had signed up to SEPA's Floodline service, including 14,918 households situated in SEPA's Flood Warning Target Areas. This represented 23% of the target population. The total number of registrations has increased in the following two years with 25,656 households now registered. The number of flood warning target areas has also been increased however, so it is not known what percentage of the target population was registered in 2016.

[196] http://www.readyscotland.org/

[197] Scottish Government (2014) *Fire and Rescue Statistics*, Scotland, 2013 – 2014, http://www.gov.scot/Publications/2014/12/2384/downloads

Figure 4.2: Households in flood warning target areas that are registered with the Floodline service



Source: Floodline user statistics, SEPA.
Notes: This calculation assumes that each household has only one signed up user.

RECOMMENDATION 14: The Scottish Government should, before the next SCCAP, assess the current level of capability within the emergency response system to deal with extreme weather events and take further steps as necessary to prepare for climate change.

4.3.3 Recovery from extreme weather events

Is there a plan?	 Amber	Plans for recovery after major events are the responsibility of local responders. These are co-ordinated by local resilience partnerships rather than as a statutory requirement of the Civil Contingencies Act.
Are actions taking place?	 Amber	Research is being undertaken by Scottish Government to map flood disadvantage in order to help target resources towards the most vulnerable communities. Guidance has been provided by Scottish Government to 'managers of care' regarding responding to the psychological and mental health needs of people affected by emergencies. However there is no evidence of advice to people or communities on recovery from extreme events.
Is progress being made in managing vulnerability?	 Grey	There is a paucity of evidence on the impacts of extreme weather events on long term health, the effectiveness of recovery plans, and the length of time it takes people and communities to recover.

Recovery from extreme events includes not only physical recovery of assets and services, but also from socioeconomic and wellbeing impacts, such as loss of jobs and social disruption. CCRA1 projected that the number of people experiencing mental health impacts in Scotland after a flood could increase by about 800 by the 2080s, but there is no present-day baseline. This demonstrates the paucity of the evidence available. Research by Sniffer[198] characterised the people most at risk as having a combination of vulnerabilities - such as high exposure through the location of their homes, existing vulnerability due to ill health, a low level of income, low quality homes and reduced mobility - and those who lack awareness of the risks and have limited support networks. Scotland's population in particular is more remote then the UK average, with 9.5% of the population being defined as living in remote towns or rural areas in 2012.[199] This can make providing assistance for recovery from extreme weather events more difficult.

Is there a plan?

Local responders have overall responsibility for coordinating recovery operations after an extreme event, but there are no national goals or targets for recovery after a major event.

Plans to recover after major events are the responsibility of local responders, such as the Fire and Rescue Service, local authorities and NHS health boards. Local resilience partnerships coordinate the actions of different responders during and after an emergency. UK-wide National Recovery Guidance is available for local responders but this lacks detail specific to Scotland. If the scale of

[198] SNIFFER (2009) *Differential social impacts of climate change in the UK*. http://www.sniffer.org.uk/files/7513/4183/8010/UKCC22_LiteratureReview_web.pdf

[199] http://www.gov.scot/Topics/Statistics/About/Methodology/UrbanRuralClassification

the event is large enough a central government resilience room is established which co-ordinates the response and recovery effort.[200]

Are actions taking place?

Actions in the SCCAP that relate to recovery from extreme events focus on research and guidance.

The action in the SCCAP to map flood disadvantage in Scotland[201] provides a valuable information source for considering where additional help might be required for recovery in the event of a flood. This research recommended that local authorities use the information for developing flood recovery strategies.

The SCCAP also makes reference to providing guidance on 'responding to the psychosocial and mental health needs of people affected by emergencies'.[202] Ownership of this is however assigned to 'managers of care', without defining this in more specific terms. There is no evidence available on of the uptake of this guidance.

Is progress being made in managing vulnerability?

As with other adaptation priorities for health and wellbeing, there is a lack of evidence to allow an assessment of how actions in the SCCAP or elsewhere are influencing recovery arrangements following extreme weather events.

Given the heterogeneity in the frequency and type of extreme events it is difficult to assess how effective actions in the SCCAP are in reducing vulnerability. Useful information to be collected would include recovery times such as length of time it takes families to return to their homes after a flood, the impacts of extreme weather events on long term health, and the effectiveness of recovery plans.

RECOMMENDATION 15: The Scottish Government should, before the next SCCAP, co-ordinate with local authorities to assess the impact on people, businesses and communities arising from flood events, including persistent health and wellbeing effects, and consider what further steps might be taken to help communities recover from extreme weather events more quickly.

[200] Scottish Government (2012) *Preparing Scotland - Scottish Guidance on Resilience*. http://www.gov.scot/Resource/0038/00389881.pdf

[201] Scottish Government (2015) *Mapping Flood Disadvantage in Scotland 2015: Research Findings*

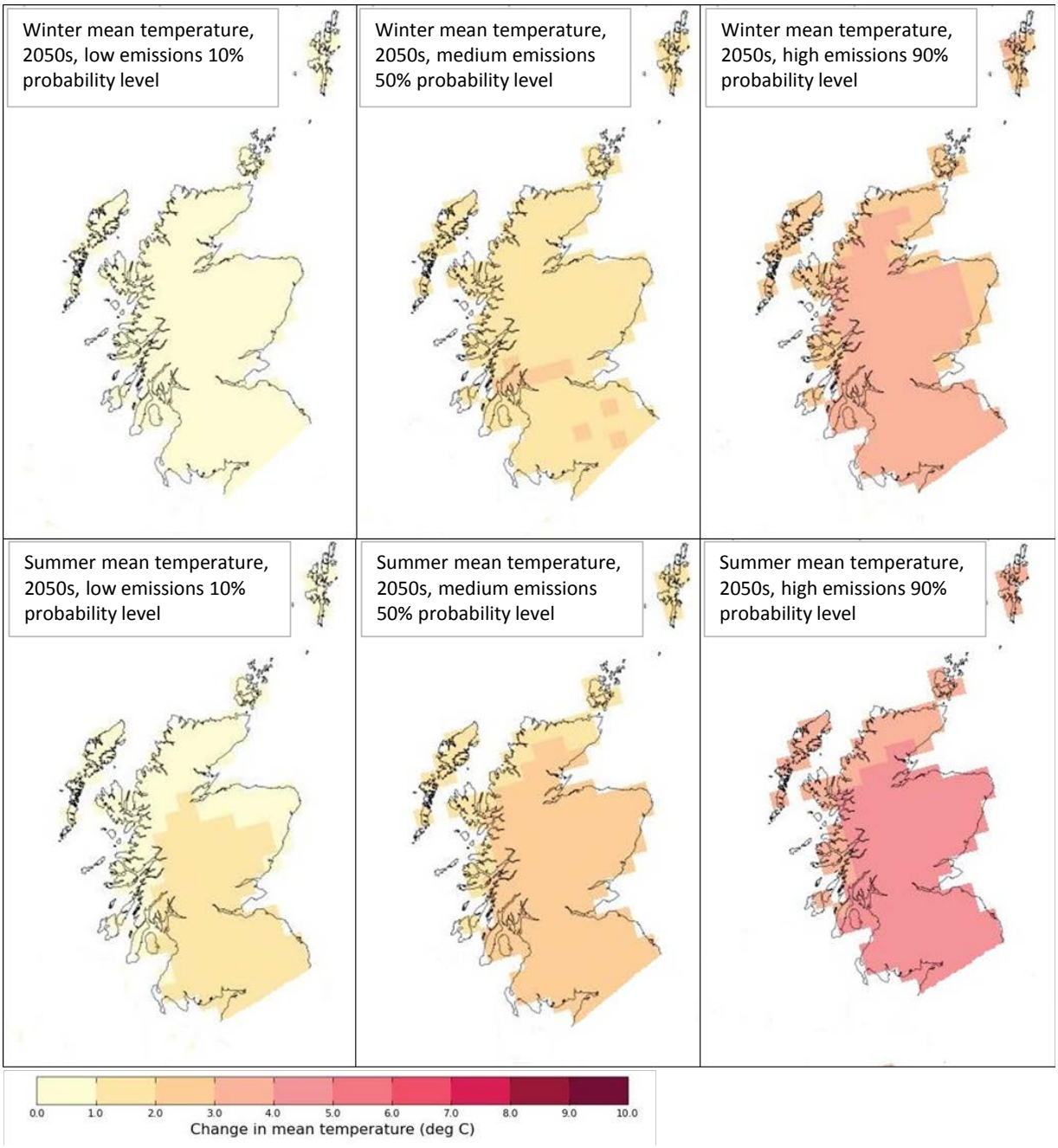
[202] Scottish Government (2009) *Preparing Scotland - Scottish Guidance on Preparing for Emergencies*. http://www.gov.scot/Publications/2009/09/17113218/15

4.3.4 Resilience of the population to changes in temperature

Is there a plan?	Amber	Managing health impacts from cold and heat when they occur during episodes of extreme temperature are covered under emergency plans. Scotland's fuel poverty strategy will help indirectly to reduce the exposure of people to cold in homes, if implemented. There are also some provisions in Building Regulations to protect occupants from extreme temperatures. However, there are no specific national plans at present that aim to prevent health impacts from occurring due to heat and cold.
Are actions taking place?	Green	Actions in the SCCAP focus on communicating to people about the risks of both heat and cold extremes through several websites and the distribution of leaflets, targeted for example at the elderly. Both heat and cold feature in NHS Scotland's climate change impact assessments for NHS facilities.
Is progress being made in managing vulnerability?	Amber	No indicators are available for internal temperatures in buildings in Scotland - these are key to understanding vulnerability to temperature changes. The average temperature across Scotland and the percentage of people aged over 75 are increasing, which is likely to increase overall vulnerability to heat. Fuel poverty is the only available indicator of exposure to cold temperatures. Whilst the proportion of people living in fuel poverty and extreme fuel poverty has decreased from 49.4% in 2011 to 44.4% in 2014, significant vulnerability remains.

Summer and winter temperatures are projected to increase across Scotland for the rest of this century. Under a medium emissions scenario, average summer temperatures are projected to increase by between 0.9 – 3.9ºC and winter mean temperatures by 0.7 – 3.0 ºC by the 2050s. A wider range of projections is shown in figure 4.3.

Figure 4.3: Projections of summer and winter temperatures for Scotland from UKCP09



Source: UK Climate projections website. http://ukclimateprojections.metoffice.gov.uk/

While the future risks to health from heat in Scotland in CCRA1 were projected to be small, they are not trivial in terms of numbers of heat-related deaths (see Section 4.1). The CCRA2 Evidence Report also projects an increase in heat-related mortality. At present, there are estimated to be around 0.7 excess deaths per 100,000 population (which with a population of 5.4 million equates to 38 heat-related deaths per year in Scotland). By the 2050s, this is estimated to increase to

between 1.3 and 5.2 per 100,000, based on the UKCP09 medium emissions scenario. This would equate to 70 – 281 excess deaths per year, higher if population growth is accounted for.[203]

There will be a potential benefit arising from warmer average winters in terms of lower heating bills and reduced cold-related mortality. However, recent studies (e.g. Hajat et al. 2014[204]) suggest that this benefit is likely to be relatively small in 2050, with a UK-wide decline in cold-related mortality of only 2% from present day estimated baseline of 41,000 deaths per year. This is because the effects of a growing and ageing population will increase the total number of vulnerable people in the population.

Is there a plan?

Scotland does not currently have a plan to prevent health-related impacts of either hot or cold weather. The Fuel Poverty Strategy, if implemented, will help to reduce overall exposure to cold in the built environment. Provisions to control internal temperatures are also included to some extent in the Building Regulations.

There are no specific plans in place that aim to prevent heat-related mortality and morbidity in Scotland at present. Local Health Boards in Scotland produce their own guidance for the public on what action to take during hot weather. Heatwaves are also covered under the UK National Risk Register, but this is not included in the Ready Scotland service as a major weather-related risk for Scotland at present.

Although there is no cold weather plan for Scotland, cold weather is also included in emergency planning guidance for Scotland. NICE has also issued guidance on measures to reduce cold impacts on health that applies across the UK.[205]

Exposure to heat and cold in buildings is an important determinant of risk as people spend around 90% of their time indoors. Provisions for controlling temperatures in buildings are set out in the Building Regulations Technical Handbook. This sets out standards related to heating and overheating (3.13), and ventilation (3.14). The overall aim of the standard is "every building must be designed and constructed in such a way that it can be heated and maintain heat at temperature levels that will not be a threat to the health of the occupants".

Plans to reduce fuel poverty can also help to reduce exposure to cold in homes. The Scottish Government's Fuel Poverty Policy aims to eliminate fuel poverty (defined as cases where over 10% of household income is spent on fuel) in Scotland by the end of 2016. The Government is also working with local authorities to provide energy efficiency measures and advice to households.

Are actions taking place?

Actions on managing temperature-related risks set out in the SCCAP, and elsewhere, primarily involve raising awareness.

Some of the policies and proposals laid out in the SCCAP include:

[203] ASC (2016) *UK Climate Change Risk Assessment 2017 – Summary for Scotland*.

[204] Hajat, S., Vardoulakis, S., Heaviside, C. and Eggen, B. (2014) *Climate change effects on human health: projections of temperature-related mortality for the UK during the 2020s, 2050s and 2080s*. Journal of Epidemiology and Community Health, 68(7), 641-648.

[205] NICE (2015) *Guideline NG6 - Excess Winter Deaths and Illness and the Health Risks Associated with Cold Homes*, https://www.nice.org.uk/guidance/ng6

- 'Ready for Winter' - a website giving advice on preparing for cold weather in Scotland.
- Guidance provided by Age UK on heat stress and the elderly.
- 'NHSInform' – A UK-wide advice portal that includes sections on dealing with both heat and cold weather.

The climate change risk assessment for the NHS estate refers to the risk of very hot days and heatwaves increasing patient demand, and affecting business continuity, as well as referencing the risk of ice and snow.

The SCCAP acknowledges that further work needs to be taken on improving public awareness of heat risks, but there are no specific actions that relate to this.

Is progress being made in managing vulnerability?

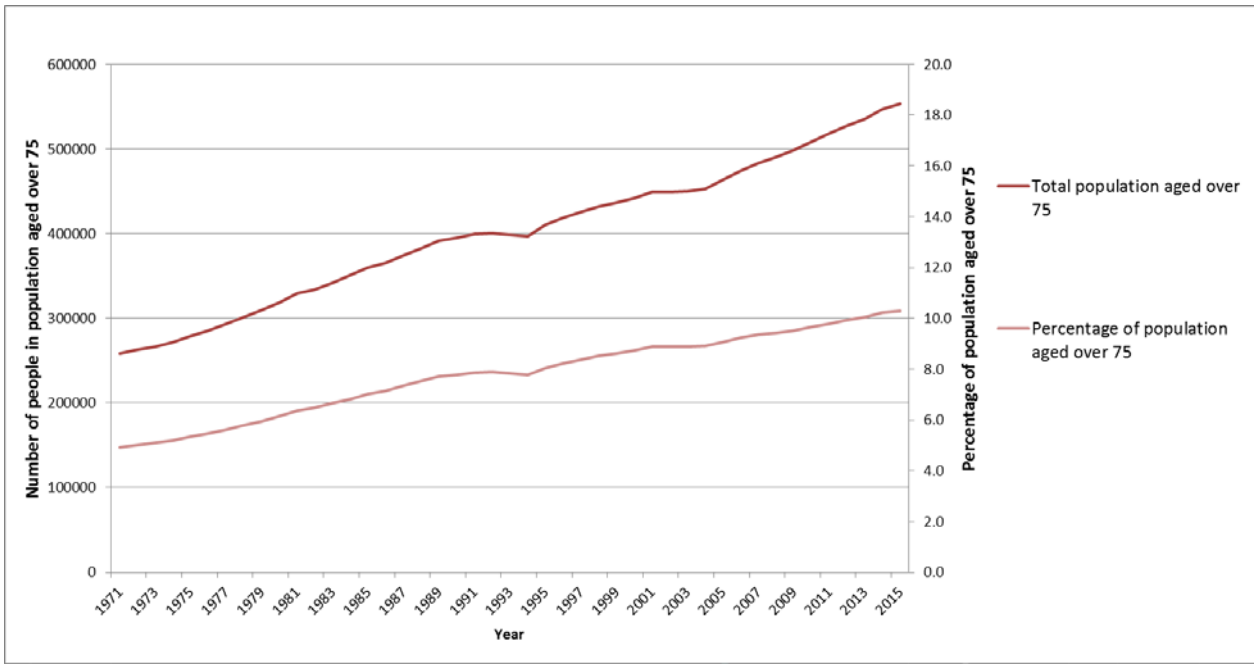
There are no indicators available at present that show trends in exposure to heat in the built environment. The number of households living in fuel poverty, a proxy indicator for exposure to cold, declined by 5% between 2011 and 2014.

At present there is little evidence on how the vulnerability of the population to heat may be changing over time. Indicators of mean and maximum summer temperatures for Scotland are not currently available, though at the UK level annual maximum temperatures have increased by 1ºC between 1961-1990 and 2006-2015.[206] Annual mean temperature has increased by about 0.7ºC between 1961-1990 and 2006-2015. [207] There are no data on temperature trends in homes, places of work, schools, hospitals and other buildings.

Socioeconomic trends such as the number of elderly people in the population are also important as a measure of how risk is changing, as people aged over 75 are more prone to negative health impacts and have an increased risk of illness and death in hot and cold weather. The proportion of the population aged over 75 has increased by 17% between 2005 and 2015 (from 0.37million to 0.44 million, see figure 4.4),[208] and these trends are set to continue in the future. By 2085, it is estimated that 18% of Scotland's population will be aged over 75.[209]

[206] Kendon, M., McCarthy, M., Jevrejeva, S. and Legg, T. (2016) *State of the UK Climate 2015*. Met Office, Exeter, UK.
[207] Ibid.
[208] http://www.nrscotland.gov.uk/files/statistics/high-level-summary/j11198/j1119802.htm
[209] Office of National Statistics, 2012-based national population projections.

Figure 4.4: Trends in number and percentage of over 75s in Scotland, 1971-2015

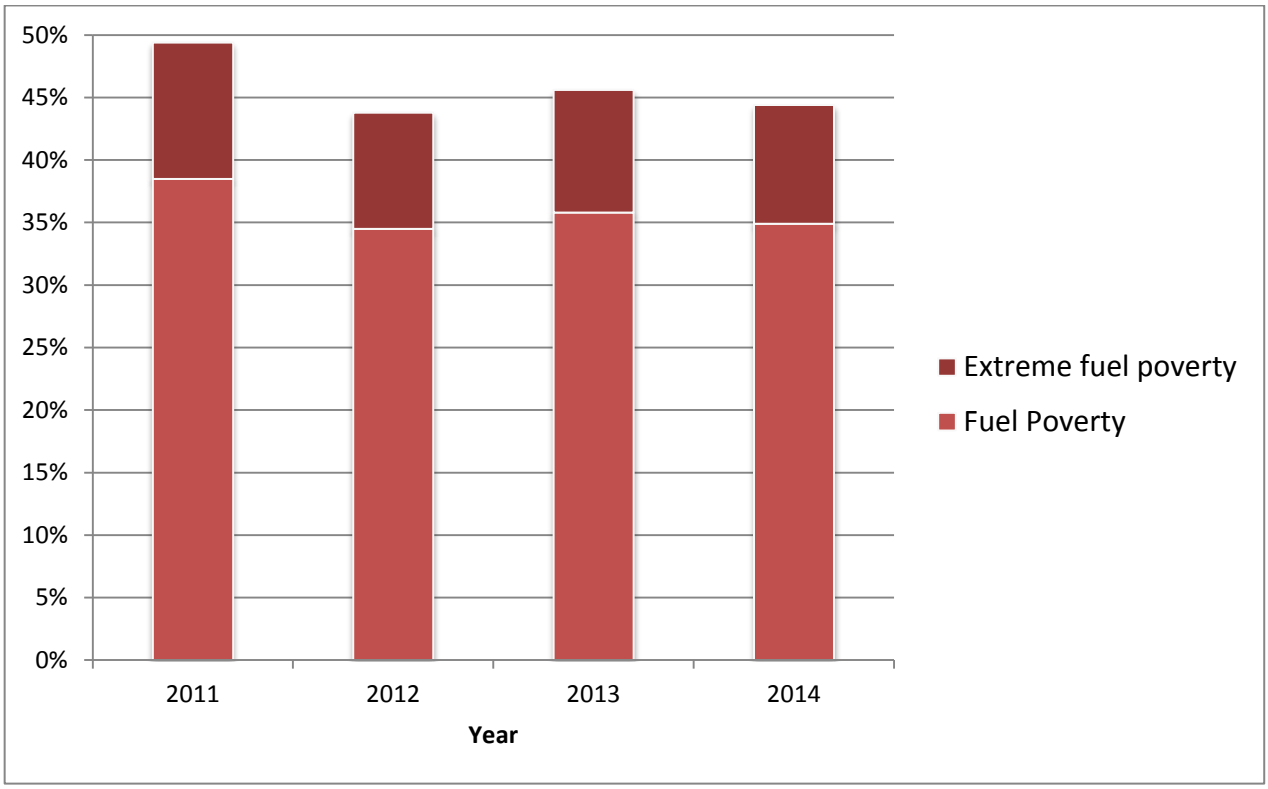


Source: National records of Scotland, mid-year population estimates.

In the absence of other evidence, the number of households living in fuel poverty is often used as a proxy indicator for exposure to cold. Between 2011 and 2013 the proportion of households living in fuel poverty (including extreme fuel poverty) decreased from 49.4% to 44.4%.[210] Although progress is being made, the Scottish Government will miss its fuel poverty target for the end of 2016 and significant vulnerability remains (Figure 4.5).

[210] Scottish Government (2015) *Scottish House Condition Survey: Key Findings 2014*. http://www.gov.scot/Publications/2015/12/8460

Figure 4.5: Percentage of Scottish households in fuel poverty, 2011-2014



Source: ClimateXChange indicator CRS61. Scottish Government Scottish House Condition Survey.
Notes: Fuel poverty is defined as those households where it is deemed that more than 10% of household income would have to be spent on fuel use. Extreme fuel poverty is defined as where more than 20% of household income is spent on household fuel costs.

RECOMMENDATION 16: The Scottish Government should, before the next SCCAP, review policies that address the current and long-term risks from both heat and extreme cold.

4.3.5 Resilience of people to pathogens, air pollution, UV radiation

The future impacts of climate change on food- and vector-borne pathogens, air pollution and UV-related health impacts are uncertain. These risks have therefore been grouped together as all require similar strategies of continuing research, monitoring and surveillance.

Is there a plan?	 Amber	The Cleaner Air for Scotland strategy seeks to limit levels of air pollutants and improve data, understanding and guidance associated with current and future risks for air pollution. An updated Food-borne Diseases strategy is currently being developed. According to Food Standards Scotland, this will consider how climate change is impacting on the prevalence of food-borne pathogens. There are no specific strategies or plans for reducing the effects of UV radiation, and there are no specific strategies for monitoring the changing prevalence of vectors and introduction of vector-borne diseases.
Are actions taking place?	 Green	Monitoring and early warning systems are in place for both air quality and UV radiation. Food Standards Scotland has regular monitoring programmes for food-borne pathogens and is currently carrying out research into transmission routes.
Is progress being made in managing vulnerability?	 Grey	The risks to public health from UV radiation, air pollution and pathogens may increase in the future as the climate changes, but it is difficult to assess how the combined effects of climate change, behaviour of the population, and changes in land use, are altering exposure to these hazards.

CCRA1 noted that the risk of new vector-borne diseases in the UK due to climate change was relatively low, but remains a possibility. Lyme disease is a vector-borne disease that is already present in Scotland. The total health burden is unknown due to incomplete detection of cases, but around 200 cases are reported each year.[211] The incidence could increase in the future with changing temperatures and rainfall, but projections are uncertain. Future trends in agriculture, land use, wild animal (host) populations and tourism will play as large or a larger role in determining future patterns of human disease, as all may influence tick prevalence, which determines disease incidence.[212] Ticks are mostly encountered in the countryside, but are also present in urban parks.

Warmer weather in Scotland could also lead to an increase in food-borne diseases such as salmonella and campylobacter. Infection rates for salmonella for example increase by 10% per

[211] http://www.hps.scot.nhs.uk/giz/lymedisease.aspx

[212] Lindgren et al. 2012. Lindgren, E., Andersson, Y., Suk, J. E., Sudre, B. and Semenza, J. C. (2012) *Monitoring EU Emerging Infectious Disease Risk Due to Climate Change*. Science, 336(6080), 418-419.

degree increase in temperature above a threshold of about 6°C.[213] While the overall number of salmonella cases is decreasing, the number of cases of campylobacter is increasing across the UK.[214] Specific trends for Scotland are not known. Future rates of infection will also be heavily influenced by future food hygiene standards.

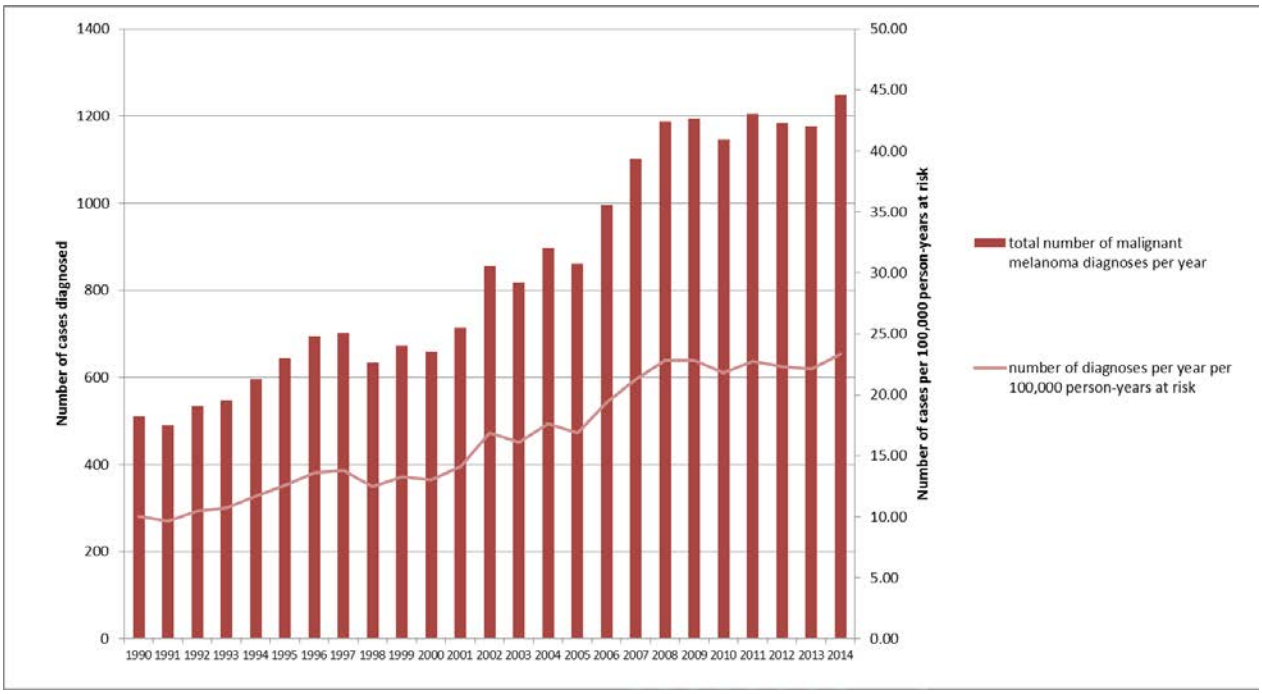
Warmer weather could also lead to an increased risk to health from air pollution, though the interaction between temperature and air pollutant concentrations is highly complex. Wetter weather could also increase algae and spore growth in damp buildings, impacting those with respiratory conditions.

Exposure to UV radiation causes long-term damage to skin and can lead to skin cancer. People can be exposed to harmful bursts of UV radiation in the UK or while holidaying abroad, or from the use of sunbeds for example.

The annual number and percentage of the population diagnosed with malignant melanoma in Scotland has increased over time from around 10 per 100,000 population (500 cases) in 1990 to 23 per 100,000 (1,200 cases) in 2014 (Figure 4.6).[215] This increase in not necessarily due to changes in UV intensity in the UK or abroad, but is likely to be influenced by behavioural factors.

The level of skin cancer could increase in the future if people spend more time outdoors in warm weather, and if periods of high UV radiation increase. Projections of this risk are highly uncertain and are strongly dependent on behavioural factors as well as climate change.

Figure 4.6: People diagnosed with malignant melanoma in Scotland, 1990- 2014



Source: Scottish Cancer Registry, ISD.

[213] Kovats, R. S., Edwards, S. J., Charron, D., Cowden, J., D'Souza, R. M., Ebi, K. L., Gauci, C., Gerner-Smidt, P., Hajat, S., Hales, S., Hernández Pezzi, G., Kriz, B., Kutsar, K., McKeown, P., Mellou, K., Menne, B., O'Brien, S., Van Pelt, W. and Schmid, H. (2005) *Climate variability and campylobacter infection: An international study*. International Journal of Biometeorology, 49(4), 207-214.

[214] ASC (2016) *UK Climate Change Risk Assessment Evidence Report: Chapter 5, People and the Built Environment*.

[215] http://www.isdscotland.org/Health-Topics/Cancer/Cancer-Statistics/Skin/

Is there a plan?

Plans exist that consider the effects of climate change on air quality and food-borne pathogens, but not vector-borne pathogens or UV radiation.

Under the Air Quality (Scotland) regulations (2000) limits are set for known air pollutants. In November 2015, Health Protection Scotland (HPS) published 'Cleaner Air for Scotland - The Road to a Healthier Future'.[216] This links air pollution objectives to those on climate change. The strategy has a specific action to translate World Health Organisation guidelines on particulate matter into legislation, though this does not include ground level ozone and aeroallergens which are particularly climate-sensitive. There is also an action for Joint Health Protection Plans to address local air pollution issues, and to improve regional and local air pollution models to better address key uncertainties and provide open access data.

Food Standards Scotland (FSS) is responsible for implementing the Food-borne Disease Strategy. FSS is currently consulting on the next strategy, which will set the policy direction on food safety in Scotland over the next five years. According to FSS, the monitoring of emergent pathogen risks which are attributable to climate change will be addressed under the new strategy. The potential increase in vector-borne pathogens as a result of climate change has not yet been considered in plans, despite the 2011 health and wellbeing sector adaptation plan committing to do so. There is also no strategy for reducing the health effects of UV radiation among the Scottish population.

Are actions taking place?

Various activities are underway to provide advice and monitor current risks from food and vector-borne pathogens, air pollution and UV radiation.

The future impacts of climate change on air quality, food- and vector-borne pathogens and skin cancer incidence are uncertain. Research, monitoring and early warning systems are useful to help judge how the level of risk may evolve with climate change.

There are a number of guidance and early warning methods available to consumers via:

- Food Safety and Hygiene advice on Food Standards Scotland's website;
- Five day air quality forecasts – also published online;
- 'Know and Respond217'- an air pollution warning system (online and via alerts);
- 'Sunsmart' – leaflets and a website provided to schools and the general public on the risks from UV radiation;
- The Met Office UV index – available via the Met Office website and the extreme weather alerts system.

For pathogens, both HPS and FSS have monitoring systems in place. Whilst FSS are carrying out research into the main food borne diseases related to climate change, HPS do not currently report how much is currently being spent on monitoring potential changes in specific vector-borne pathogens. This is because surveillance is undertaken as part of HPS's core function and is not apportioned to specific pathogens or vectors.

[216] Scottish Government (2015) *Cleaner Air for Scotland, the Road to a Healthier Future.* http://www.gov.scot/Publications/2015/11/5671

[217] http://www.scottishairquality.co.uk/know-and-respond/

Is progress being made in managing vulnerability?

No indicators are available that allow vulnerability to air pollution, UV and pathogens to be monitored.

It is difficult to measure how the exposure and vulnerability of the population to pathogens is changing. Indicators that could be populated to help to measure trends include the distribution of tick bites across Scotland (as a measure of vulnerability to Lyme disease), or spend on surveillance efforts for specific pathogens as an action indicator.

Indicators that could measure vulnerability to air pollution episodes include the number of people in Scotland living with chronic respiratory conditions, as well as background levels of ground level ozone and PM2.5.

UV levels are recorded at various locations around the UK, including sites in Glasgow, Lerwick and Inverness, as well as two sites overseas in Gibraltar and Cyprus.[218] Time series are available for these locations.

RECOMMENDATION 17: Health Protection Scotland should, before the next SCCAP, carry out new research into the current and future risks to the population from heat and UV radiation, and consider proportionate responses to the risk.

RECOMMENDATION 18: Health Protection Scotland should, before the next SCCAP, assess the changing risks to people from vector-borne diseases, making use of the second UK Climate Change Risk Assessment Evidence Report. This should consider priority areas for future monitoring and surveillance and whether current resources are aligned with the areas of greatest current and future risk.

4.3.6 Public understanding of climate related risks

Is there a plan?	 Green	The SCCAP contains an objective to increase the awareness of people to the impacts of climate change and includes specific actions to achieve this.
Are actions taking place?	 Green	The SCCAP includes various actions on raising awareness through the Ready Scotland website, improving education on flood risk management in schools, and via Adaptation Scotland's work with communities such as Scottish Rural Action. Adaptation Scotland's workplan (to March 2018) includes communication on a community scale. SEPA is responsible for activities to raise awareness of flood risk.
Is progress being made in managing vulnerability?	 Grey	No information is available on the level of public awareness of climate change in Scotland, nor how this is being influenced by the engagement activity being undertaken.

[218] https://uk-air.defra.gov.uk/data/uv-index-graphs

Raising awareness about the effects of climate change is likely to be most effective when people are already dealing with the effects of extreme weather. Research has shown that awareness is generally raised through experience of extreme events such as floods.

Is there a plan?

One of the three objectives for each theme in the SCCAP is to raise awareness of people and organisations to the effects of climate change.

As such, awareness raising sits at the heart of climate change adaptation policy in Scotland. This includes providing information and guidance to the public as well as public and private sector organisations.

Actions on raising awareness tend to cut across many different organisations in Scotland, including local authorities and third sector organisations such as the Scottish Communities Climate Action Network. [219] No single organisation or individual has accountability for engaging with the public on climate change.

Are actions taking place?

There are 15 actions in the society theme of the SCCAP that cover raising awareness. These include:

- 'Ready Scotland' website – A source of advice and information on anything from wet weather to flu outbreaks;
- 'Ready for emergencies' resilience resource for Schools – An online tool for children to inform them about the impacts of severe weather and flooding;
- outreach work being carried out by the Scottish Flood Forum.

Adaptation Scotland's work programme is specifically designed to encourage a partnership approach to adaptation. Whilst they do not have a specific engagement programme focusing on the general public, they working with organisations, businesses and communities to become more 'climate ready'. For example, an Adaptation Learning Exchange for community engagement has been set up which aims to develop new resources and support the integration of adaptation as part of wider community engagement, development and regeneration.

Adaptation Scotland are also working with PAS (formerly Planning Aid for Scotland[220]) to include adaptation as part of a wide range of community engagement and education projects. This includes running adaptation sessions in schools and raising awareness of adaptation plus projects that support communities to discuss and share ideas for the future of their community.

An example of the type of work being undertaken with communities is shown in Box 4:1.

[219] http://www.scottishcommunitiescan.org.uk/are-we-ready/
[220] http://pas.org.uk/

Box 4.1: Case Study - Climate Ready Clyde

In March 2016, the Scottish Government announced funding for 'Climate Ready Clyde', a new partnership between public sector, businesses and community organisations across Glasgow and the Clyde valley to work together on climate change adaptation at a regional scale. Organisations involved in developing the Climate Ready Clyde partnership include the Glasgow and Clyde valley strategic planning authority, Glasgow and Clyde Valley Green Network Partnership, local authorities, the regional transport partnership, third sector organisations, businesses, and government agencies.

A vision for a Climate Ready Clyde was published in 2013 and the new partnership will lead work to develop an action plan to realise this vision.

Source: http://www.sniffer.org.uk/knowledge-hubs/sustainable-places/climate-ready-clyde/

Is progress being made in managing vulnerability?

At present there is no monitoring of the impact that programmes are having in raising awareness.

Data is not collected on the uptake of guidance related to climate change or the impacts of extreme weather. No surveys of public awareness have been carried out in Scotland. Monitoring of levels of awareness and understanding of climate change would be a useful exercise to gauge the success and cost-effectiveness of the SCCAP actions, and ascertain if the objective on awareness-raising is being met.

RECOMMENDATION 19: The Scottish Government should, before the next SCCAP, review the take-up and impact of guidance and tools for organisations, businesses and communities provided by Adaptation Scotland.

4.3.7 Business impacts from extreme weather

Is there a plan?	 Amber	Some hazard specific guidance is in place for businesses; however there is currently no co-ordinated government plan to increase business resilience to severe weather. SEPA's 14 flood risk management strategies (FRMSs) lay out action to address flooding in areas where the benefits of intervention have the greatest impact. The impact on businesses is included in this calculation.
Are actions taking place?	 Green	Adaptation Scotland, SEPA and the Scottish Flood Forum have published guidance and tools for businesses to adapt to flooding and other extreme weather. Businesses in Scotland can sign up to Floodline Scotland to receive Flood Alerts and Warnings.
Is progress being made in managing vulnerability?	 Amber	There has been an increase in the number of businesses in the UK with business continuity plans in place; although about 40% do not have such plans. The limited evidence available suggests that the up-take of property-level protection measures by UK businesses is low, while no data are available on the up-take by Scottish businesses alone.

Businesses in Scotland are at risk from a range of climate change-related impacts. These range from direct damage to businesses premises from flooding, to more indirect impacts on staffing and supply chains from travel disruptions and extreme weather. CCRA1 highlighted the threat of flooding as well as potential overheating in the work environment. Flooding imposes significant costs on businesses, both in terms of damage to assets and in disruption to business activity, while overheating may decrease the productivity, safety and comfort of workers in certain industries or occupations. Impacts on business may then have knock-on effects to the communities in Scotland they provide services to.

Is there a plan?

Flood risk management strategies take the impacts on businesses into account but there is no coordinated government plan to increase business resilience to severe weather.

Although there is no government plan to increase business resilience, businesses will benefit from national plans to tackle climate hazards such as flooding.

Activity to prevent flood damage to businesses is currently being driven by the Scottish Government's general approach to flood risk management. SEPA produced Flood Risk Management strategies for 14 Local Planning Districts (LPDs). These aim to help individuals, local communities and businesses to understand local levels of flood risk and how this will be managed.

Businesses have an obligation under the health and safety at work regulations to ensure workplaces are adequately ventilated and temperatures during working hours are reasonable. To support UK businesses in meeting this requirement, the Health and Safety Executive has published workplace temperature guidance.

Are actions taking place?

Organisations such as Adaptation Scotland, SEPA and the Scottish Flood Forum are helping Scottish businesses prepare for, and build resilience to, the impacts of climate change.

Adaptation Scotland is funded by the Scottish Government to provide advice and support to help organisations, businesses and communities in Scotland prepare for, and build resilience to, the impacts of climate change. Businesses have free access to advice and capacity building training including the Adaptation Learning Exchange. Businesses are also encouraged to collaborate with public sector partners and communities through place based projects such as the Edinburgh Adapts initiative. In their 2015 annual report, Adaptation Scotland noted the publication of their 'climate risk management plan' template, which aims to provide Scottish businesses with a simple, streamlined approach to assessing and managing their climate risks. The template was piloted with Royal Mail and ScotRail, and has since been promoted and used across both marine and land-based sectors.

Tools and guidance on flood protection are also provided by SEPA and the Scottish Flood Forum. This includes guidance for businesses on creating flood plans and advice on flood insurance. SEPA works in partnership with local authorities, Neighbourhood Watch Scotland, Ready Scotland and others to promote preparedness and understanding of flood risk in Scotland. Businesses in Scotland can sign up to Floodline to receive Flood Alerts and Warnings. Over 1,900 businesses have registered. This may be an underestimate since business owners or managers may have signed up to the service as individuals but receive flood warnings specifically for their business premises rather than their own personal properties.

Scottish businesses are also able to access training courses, tools and guidance available to all UK businesses provided by the Environment Agency through the Climate Ready programme, Climate UK, the Cabinet Office, and the Institute of Environmental Management and Assessment (IEMA). The tool helps businesses identify whether they are at risk of flooding and brings together the Agency's advice on the steps that businesses can take to protect themselves. Data are not available to suggest the take-up or impact of the tools and guidance provided by Adaptation Scotland.

Changes to management standards could encourage more firms to consider the potential benefits from adapting premises to avoid heat stress and other climate risks. Management standards provide guidance and models for businesses to follow based on international, expert consensus. There are a number of initiatives currently underway. For example, the 2015 version of ISO14001 set out a framework that a company can follow to set up an effective environmental management system. Around 16,900 businesses in the UK are certified to ISO 14001, and this number has been increasing at a rate of around 1,000 businesses per year.[221]

Is progress being made in managing vulnerability?

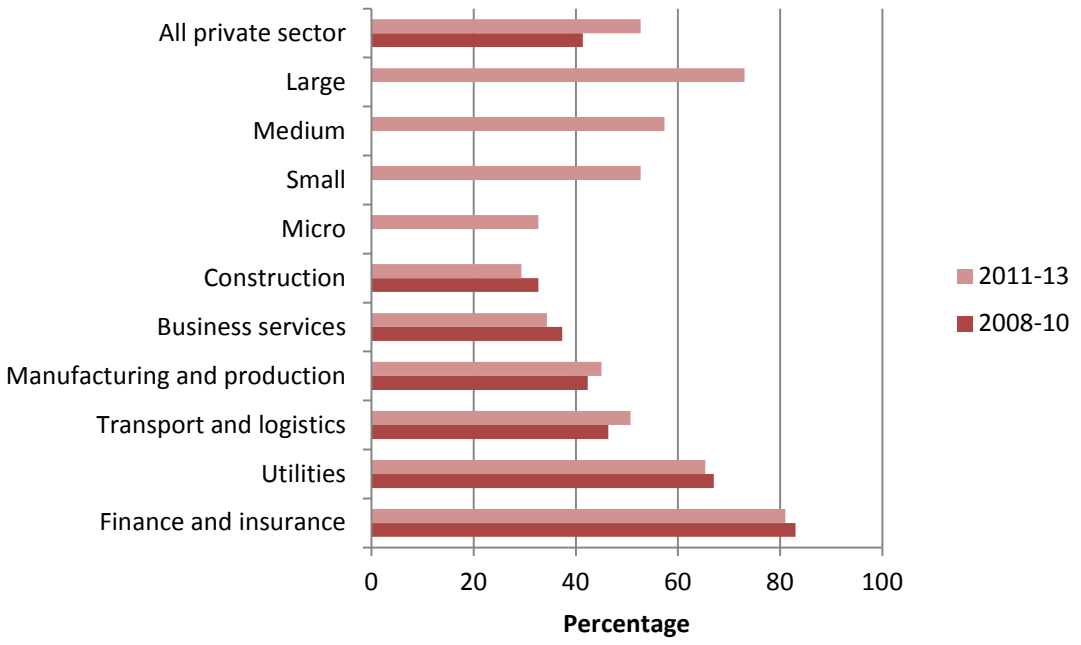
Evidence suggests one in three Scottish businesses have been significantly affected by climate hazards and that UK businesses find the benefits of having business continuity plans exceed the costs. However, their uptake remains low.

A survey conducted between December 2012 and January 2013 of 260 private Scottish businesses suggested more than one in three (36%) businesses had been significantly affected

[221] ISO (2015). ISO survey 2013. http://www.iso.org/iso/iso-survey

by climate hazards between 2010-2012, with the most common experience being localised flooding.[222] Business continuity plans support businesses to respond to and recover from extreme events, such as a flood event. The proportion of surveyed UK private sector organisations (including some respondents from Scotland) reporting that they have a business continuity plan in place rose from 42% in 2008 to 58% in 2013.[223] Figure 4.7 sets out results from this survey for different business sectors and sizes. Extreme weather events such as flooding are consistently the main reason for businesses activating these plans. Around four-fifths of businesses with continuity plans in place report that the benefits of having a plan exceed the costs of producing one. This suggests business continuity plans are an effective low-regret adaptation measure. Despite the benefits identified, the uptake of business continuity plans remains relatively low, particularly amongst micro businesses and businesses in the construction sector. Research by the Federation of Small Businesses suggests 93% of small businesses believe severe weather poses a risk to some part of their business but only 64% have taken any action to manage the risk.[224]

Figure 4.7: Percentage of UK businesses with business continuity plans in place



Source: Chartered Management Institute (2013). Weathering the Storm.
Notes: The sample was selected from CMI's membership, with 25,000 individuals sent a link to the survey by email. A total of 637 responses were received. The sample group represents general managers across UK organisations, rather than those with specific responsibility for BCM. Only a sub-group including those managers who reported that their organisation has BCM were asked more detailed questions.

[222] Ipsos MORI (2013). *Climate Change adaptation survey: Scotland findings*.
[223] Chartered Management Institute (2013). *Weathering the Storm: 2013 Business Continuity Management Survey*. http://www.managers.org.uk/insights/research/currentresearch/2013/march/weathering-the-storm
[224] Federation of Small Businesses (2015). *Severe Weather: A More Resilient Small Business Community.* http://www.fsb.org.uk/frontpage/assets/fsb-severe-weather-report-final.pdf

RECOMMENDATION 20: The Scottish Government should, before the next SCCAP, develop policies to encourage businesses in high risk areas to become more flood resilient and report on the actions being taken by businesses as a result.

4.3.8 Business opportunities from climate change

Is there a plan?	Amber	At the UK level, plans are in place to better understand the adaptation goods and services market and how to promote business opportunities that might arise from the changing climate such as longer tourism seasons. There is no bespoke plan focusing on opportunities for Scottish businesses. However, 'the Scotland the Hydro Nation' programme aims to develop the value of Scotland's significant water resources.
Are actions taking place?	Amber	Research is being carried out to develop understanding of the opportunities for UK businesses but may miss specific sectors and opportunities relevant to Scotland. The Scottish Cities Alliance commissioned 'Low Carbon and Climate Change Adaptation Opportunity Assessments' for each Scottish city and Scottish Enterprise promote exports by Scottish companies, including in new markets.
Is progress being made in managing vulnerability?	Amber	UK companies have expertise in many types of adaptation goods and services. Sales have increased at a faster rate than overall growth in the economy in recent years. However, UK sales growth has been slow compared to overseas competitors.

Climate change presents opportunities to businesses from the development of the adaptation goods and services supply chain, and changes in demand for leisure and retail activities that could increase in warmer weather. CCRA1 also suggested higher temperatures may also make Scotland a more popular tourist destination.

Please note, we have found limited Scotland-specific evidence on the business opportunities from climate change (other than in relation to water resources, see below). Therefore, this assessment draws upon UK-level data that will include a sample of businesses based in Scotland.

Is there a plan?

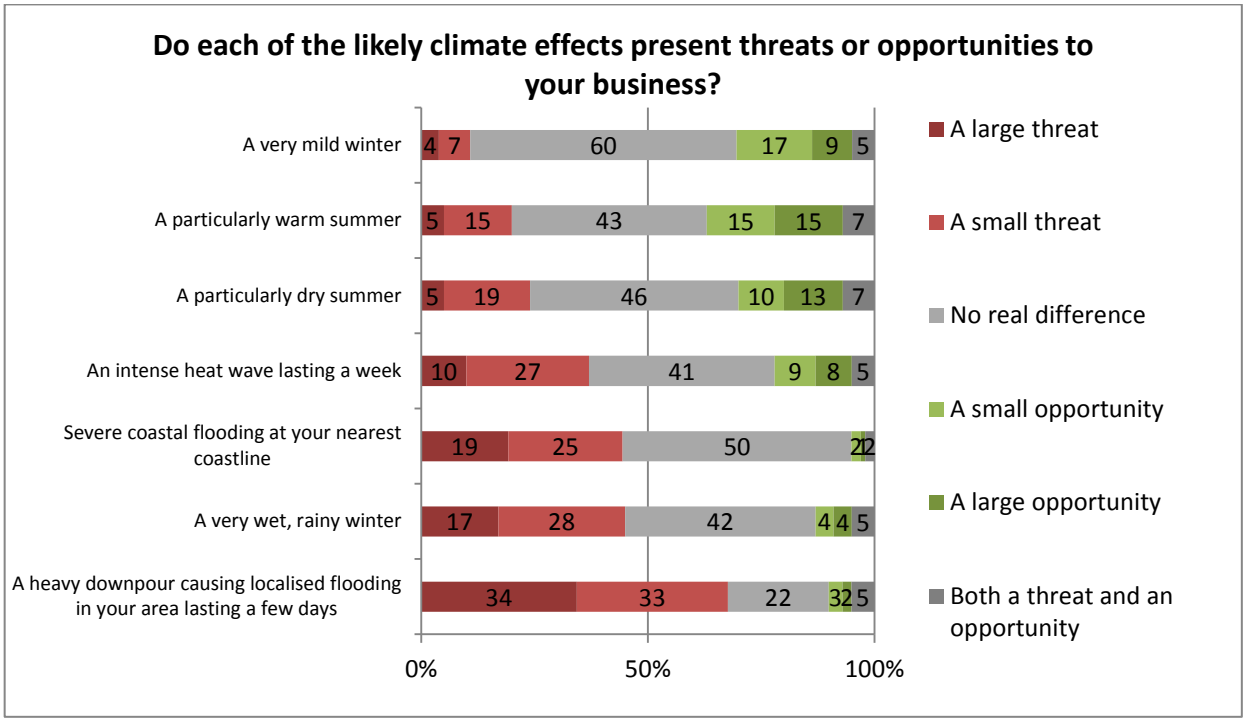
There is no bespoke plan focussing on opportunities for Scottish businesses, although there are examples of individual initiatives.

Businesses continuously adjust to changes in market conditions and can be expected to take advantage of any opportunities that arise. Research by Ipsos MORI shows that of the Scottish businesses surveyed, 30% see particularly warm summers and 26% milder winters as opportunities.[225] Figure 4.8 sets out further results from this survey, providing an indication of

[225] Ipsos MORI (2013) *Climate Change adaptation survey: Scotland findings*

Scottish businesses' perceptions of different climate change threats and opportunities.

Figure 4.8: Views of Scottish businesses on climate change and extreme weather



Source: Ipsos MORI (2013) Climate change adaptation survey: Scotland findings December 2012 – January 2013.
Notes: From a sample of 260 private businesses. May not sum to 100% due to rounding.

In some cases there may be a role for government policy in addressing potential barriers to growth. Whilst there has not been a comprehensive assessment of business opportunities with climate change, there are examples of individual initiatives. One example is the Scottish Government's 'Scotland the Hydro Nation' initiative, which aims to develop the monetary and non-monetary value of Scotland's water resources. This includes raising Scotland's international profile on water management through knowledge exchange, developing trade opportunities for services, relevant manufacturing and research. The programme aims to take advantage of Scotland's water resources when elsewhere they may become scarcer.

SEPA launched a new regulatory strategy in 2016. It aims to support businesses who seek to find innovative and efficient ways to go beyond standard levels of compliance. Part of how it will do this is through providing information and evidence that aids decision makers. Sector plans will be developed for each sector that SEPA regulates. The Climate Change (Scotland) Act 2009 requires public sector bodies, including Highland and Islands Enterprise, Scottish Enterprise and VisitScotland, to report on what they are doing to adapt to climate change, including how they are supporting delivery of relevant policies and programmes in the SCCAP.

Are actions taking place?

Despite the lack of plans, actions are taking place but research is focussed on the UK and may miss specific sectors and opportunities relevant to Scotland.

The Scottish Cities Alliance (SCA) is tasked with attracting external investment, stimulating economic activity and creating new jobs and business opportunities. For each of the seven Scottish cities, the SCA commissioned a 'Low Carbon and Climate Change Adaptation Opportunity Assessment'. These assessments recommended a number of common high-level measures which should be promoted to improve resilience and could offer opportunities to local businesses such as improvements in building design, blue green infrastructure, SuDS and natural flood management.

The University of Stirling and SEPA collaborated to launch the Centre for Sustainable Practice and Living in 2015. This centre will act as a hub for research and education, and seek to encourage collaborations between the civic, business and public sector. It will offer an executive education programme for senior decision makers, including on how to adapt their own business models and recognise climate opportunities.

Research is being carried out to develop the understanding of the opportunities for UK businesses. For example, Defra has worked with the Office for National Statistics (ONS) to explore the feasibility of collecting information on the adaptation economy via a survey. Scottish Enterprise helps promote exports, including those in new markets. However, in its 2015-2018 business plan, Scottish Enterprise does not explicitly cover adaptation goods and services. Research outputs or other actions will be focussed on the UK as a whole (and perhaps only on England). This may miss specific sectors and opportunities relevant to Scotland.

Is progress being made in managing vulnerability?

Sales of UK adaptation goods and services have grown at a faster rate than overall growth in the economy but slower than some overseas competitors.

The UK has an advantage relative to other countries in the finance, insurance, architectural and consultancy sectors, which form a significant part of the market classed as adaptation goods and services. Qualitative assessments conducted by PwC and GHK consulting have found the UK is already a key provider of adaptation goods and services in these sectors.[226] Previous analysis by the ASC also found businesses in the UK already export goods and services that require similar skills and technologies to adaptation goods and services.

Patent data shows UK businesses are an important provider of adaptation technologies and ideas which in turn can be converted into commercial opportunities. The number of patents registered each year by UK companies for technologies to manage the demand and supply of water increased by around 80% between 1990 and 2010.[227] The proportion of all water-related adaptation patents registered globally by UK companies is higher than their share of all world patents, suggesting companies have a relative advantage in the development of these technologies.

Estimating the size of the sector is difficult as adaptation goods and services are sold by a variety of different industry sectors, and national statistics agencies in the UK and globally do not currently collect data on the size and composition of the market. The data that are available

[226] GHK (2010). *Opportunities for UK Business from Climate Change Adaptation*. http://www.greensuffolk.org/assets/Greenest-County/Adaptation/General/Business/Business-opportunities-from-climate-adaptation.pdf and PwC (2013). *International threats and opportunities of climate change for the UK*. http://pwc.blogs.com/files/international-threats-and-opportunities-of-climate-change-to-the-uk.pdf

[227] Conway, D., Dechezleprêtre, A., Haščič, I. and Johnstone, N. (2015). *Invention and diffusion of water supply and water efficiency technologies: insights from a global patent dataset*. http://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2015/06/Working-Paper-196-Conway-et-al.pdf

suggest the UK is the seventh largest producer globally of adaptation goods and services, with sales of £2.1 - £6.1 billion in 2011/12.[228] This is small when compared to the combined turnover of UK businesses of more than £3 trillion in 2011.

The annual growth in sales of adaptation goods and services by UK companies between 2009/10 and 2011/12 was 2.3%. This is higher than annualised economic growth of 1.4%. However, the data suggest sales growth by UK companies has lagged behind growth in all of the other top ten largest producing countries.[229]

RECOMMENDATION 21: The Scottish Government should include actions within the next SCCAP that will help businesses in Scotland understand and exploit the economic opportunities arising from climate change.

4.3.9 Supply chain disruptions

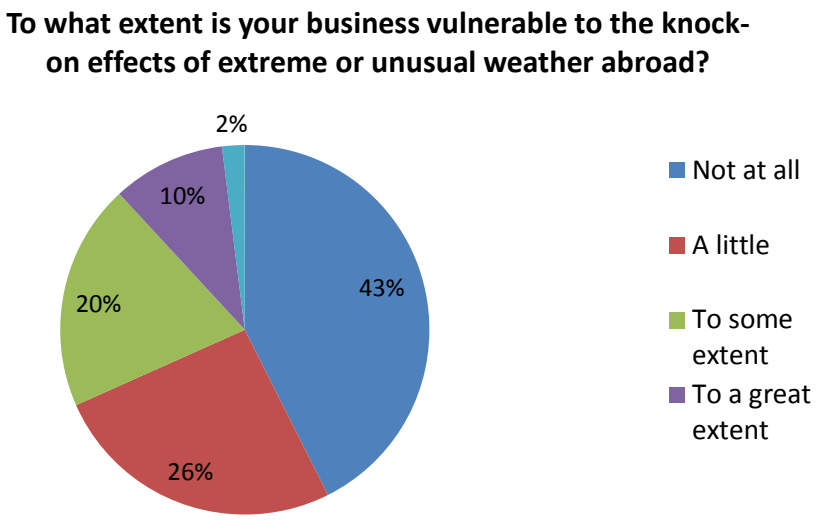
Is there a plan?	 Amber	Guidance and support is available to companies wishing to assess and manage their vulnerability to disruptions. For example, the Market Driven Supply Chain project aims to support and maintain food and drink supply chains. However there is no overarching plan to address any systemic risks for the benefit of Scottish businesses in general.
Are actions taking place?	 Amber	Adaptation Scotland has published a climate change risk management template, and guidance is available from other sources such as the Institute of Environmental Management and Assessment. Data are not available on the take-up of such guidance and tools in Scotland.
Is progress being made in managing vulnerability?	 Amber	Measuring progress is difficult due to the complexities of supply networks. Self –reported data by large companies at the UK level suggest some management of risks to suppliers but this is far from universal. Current actions focus on identifying alternative suppliers but there is the potential for companies to be more proactive and work with their existing suppliers and supply chains to promote long-term resilience.

Through their international supply chains, businesses in Scotland are exposed to the risks of climate change around the world. Extreme weather events, such as flooding, storms and drought, are already common causes of supply chain disruptions. The Business Continuity Institute's (BCI) Supply Chain Resilience Report (2015) found that adverse weather was the second most cited reason for supply chain disruption over the previous 12 months, affecting 43% of surveyed UK businesses. The impacts of disrupted supply chains can be both immediate, like a drop in productivity and unfulfilled orders leading to a dip in share price, and persistent, such as damage to brand reputation, an increase in regulatory scrutiny, and losses of regular

[228] K-Matrix (2013) for BIS. *Adaptation and resilience to climate change (ARCC): Report for 2011/12.*
[229] ASC analysis of K-Matrix (2013) for BIS.

customers and market share. As such supply chain disruptions have been known to have long-term effects on shareholder value.[230] Research by Ipsos MORI shows that of the Scottish businesses surveyed three in ten (30%) say they are vulnerable, at least to some extent, to the knock-on effects of extreme or unusual weather abroad. However, most are not concerned by these effects with one in four (26%) saying they are vulnerable only to a little extent, and two in five (42%) not at all. Figure 4.9 sets out these results in full.

Figure 4.9: Views of Scottish businesses on the knock-on effects of extreme or unusual weather abroad



Source: Ipsos MORI (2013) Climate change adaptation survey: Scotland findings December 2012 – January 2013.
Notes: From a sample of 260 private businesses. May not sum to 100% due to rounding.

Is there a plan?

There is no overarching plan to address systemic risks to Scottish businesses' supply chains, although guidance and support is available for some sectors.

Businesses in Scotland operate as part of the global economy and as such are heavily reliant on resources, goods and services sourced from and sold to overseas markets. Regional trade statistics indicate the value of Scotland's exports increased from £12.6 billion in 2005 to £17.5 billion by 2015. Over the same time period the value of Scotland's imports increased from £9.8 billion to £13 billion. There is currently no overall assessment of specific or systemic risks to Scottish businesses from vulnerable supply chains, and there is no plan to act on such risks should they be identified.

The Market Driven Supply Chain Project[231] (MDSC) is funded by Scottish Government and Scottish Enterprise and is designed to help unlock barriers preventing Scottish food and drink supply chains exploiting major market opportunities. Through a competitive process,

[230] World Economic Forum and Accenture (2013). *Building Resilience in Supply Chains*. http://www3.weforum.org/docs/WEF_RRN_MO_BuildingResilienceSupplyChains_Report_2013.pdf
[231] http://mdsc.scot/

intervention support can be made available at any point of the supply chain, to sector-based projects and to collaborative interventions. The MDSC project helps to increase efficiency or reduce waste within supply chains, and consider if supply chains will work effectively in the same way in the future.

Are actions taking place?

Adaptation Scotland and other organisations have published tools and guidance but it is not clear if these are being used by businesses to take action.

Despite the lack of overarching plan, actions are taking place. The Scottish Government published guidance: 'Preparing Scotland, Having and Promoting Business Resilience' (2013) which encourages businesses to consider the resilience of their supply chains as part of managing their own resilience. Adaptation Scotland has published a climate change risk management template, and guidance on managing supply chain risks is available from other sources such as the Institute of Environmental Management and Assessment and the Environment Agency. The Environment Agency's guidance sets out a series of questions to help businesses identify whether their supply networks are vulnerable to the effects of climate change and extreme weather. Data are not available on the take-up of existing guidance and tools by Scottish businesses.

Is progress being made in managing vulnerability?

Self-reported data from some large companies suggest that they are managing risks, but it is difficult to determine overall vulnerability, particularly for international supply chains.

Some large multi-national companies report that they have identified, and are actively managing, climate risks to their supply chains. However, action is far from universal. Two-thirds of large multi-national businesses that report no climate risks to supply chains are in the same sub-sectors as firms identifying one or more risks. A lack of awareness and action could put these companies at a competitive disadvantage. It is difficult to determine the overall vulnerability of Scottish businesses to supply chain disruptions without greater information disclosure by companies and a more systematic assessment by the government.

Previous analysis by the ASC[232] identified that international supply chains in the food and drink, electronic equipment, clothing and some other manufacturing sectors are the most vulnerable to disruption from climate change. The findings highlighted that the greatest risks appear to be in the lower-tiers of supply chains, such as the sourcing of raw materials. These tiers of the supply chain are more difficult to be traced and be understood and actively managed by UK businesses and therefore take longer to prioritise. There is no specific data for international supply chains in Scotland.

[232] University of Leeds (2014). *Estimating global value chain impacts associated with UK consumption patterns.* Report for the Adaptation Sub-Committee. https://www.theccc.org.uk/publication/managing-climate-risks-to-well-being-and-the-economy-asc-progress-report-2014/

4.3.10 Water demand by industry

Is there a plan?	 Amber	All abstractors have a duty under the Controlled Activities Regulations to use water efficiently. 'Scotland the Hydro Nation' aims to support, attract and develop opportunities for businesses or industries for whom a large volume of water is a critical resource. It is not clear how this programme is taking into account the projections of water scarcity in some parts of Scotland.
Are actions taking place?	 Green	Scottish Government's free advice and support programme 'Resource Efficient Scotland' published a guide to improving water efficiency and promotes case studies of good practice. Evidence suggests parts of the food and drink manufacturing sector in Scotland are reducing their water use. Data are not available for other sectors.
Is progress being made in managing vulnerability?	 Grey	Non-domestic consumption of public water supplies decreased between 2008-09 (466 Ml/d) and 2013-14 (410 Ml/d). However, it is not possible to determine how much of this was due to improvements in efficiency. Data on direct abstractions by industry over time are not available.

Water is used by industry for cooling and heating, washing products, dissolving chemicals, suppressing dust, and also as a direct input to products. Without sufficient water, production in many businesses would have to be reduced or stopped.

Is there a plan?

Plans are in place to prepare for water scarcity and use water more efficiently, although it is not clear how these are incorporated in aims to attract businesses for whom a large volume of water is a critical resource.

All abstractors have a duty under Regulation 5 of the Controlled Activities Regulations (CARs) to use water efficiently. The CARs were amended in 2011 to include emergency provisions to allow SEPA, in certain circumstances, to amend existing authorisations or issue new authorisations to cope with prolonged periods of dry weather. SEPA identify catchments under pressure from abstraction in River Basin Management Plans and work with appropriate stakeholders to develop site and sector-specific solutions. SEPA has also published a national water scarcity plan. This plan sets out how SEPA will use the rainfall and flow data it collects to regularly communicate information on current water scarcity risk and how SEPA will work with businesses and other agencies to manage the impacts of water scarcity through sector-specific actions.[233]

'Scotland the Hydro Nation' aims to support, attract and develop opportunities for businesses or industries for whom a large volume of water is a critical resource. This includes those of strategic

[233] Scottish Environment Protection Agency (2016) *Scotland's National Water Scarcity Plan.* http://www.sepa.org.uk/media/219302/scotlands-national-water-scarcity-plan.pdf

importance to Scotland's economy, such as tourism, food and drinks manufacturing and renewable energy generation. It is not clear how this programme is taking into account projections of water scarcity in some Scottish regions.

Are actions taking place?

Resource Efficient Scotland promotes water efficiency and there are indications that businesses in the food and drink industry are monitoring and reducing their water use.

Resource Efficient Scotland, a free advice and support programme established by Scottish Government, published a guide to improving water efficiency. There are signs that water is being better managed by some businesses. Under the Federation House Commitment, signatories in the food and drink manufacturing industry reduced their water use (excluding that embodied in products) by 16% between 2007 and 2013. Around 10% of signatories' sites are in Scotland.[234] Research by the Scotch Whisky Association into their climate change risks noted that low flows in rivers affected a number of sites in recent years and that raised summer temperatures elevated water temperatures making the spirit production less efficient.[235] The Scotch Whisky industry subsequently reported that in 2015 net water use was down 14% from 2008 levels.[236]

Is progress being made in managing vulnerability?

Non-domestic water consumption has fallen but it is not possible to determine if this is due to improvements in efficiency or decreases in production.

Non-domestic water consumption in Scotland has fallen from 530 million litres per day in 2002/03 to 403 million litres per day in 2014/15. Figure 4.10 sets out these data. However, data are not available to determine if this is due to improvements in water efficiency. All non-domestic customers in Scotland are metered unless it is not practicable to do so. In 2015, 95% of water delivered (included losses) by Scottish Water to non-household properties was to metered properties.[237] However, annual data on abstraction by industry are not available to fully assess if vulnerability is being managed over time.

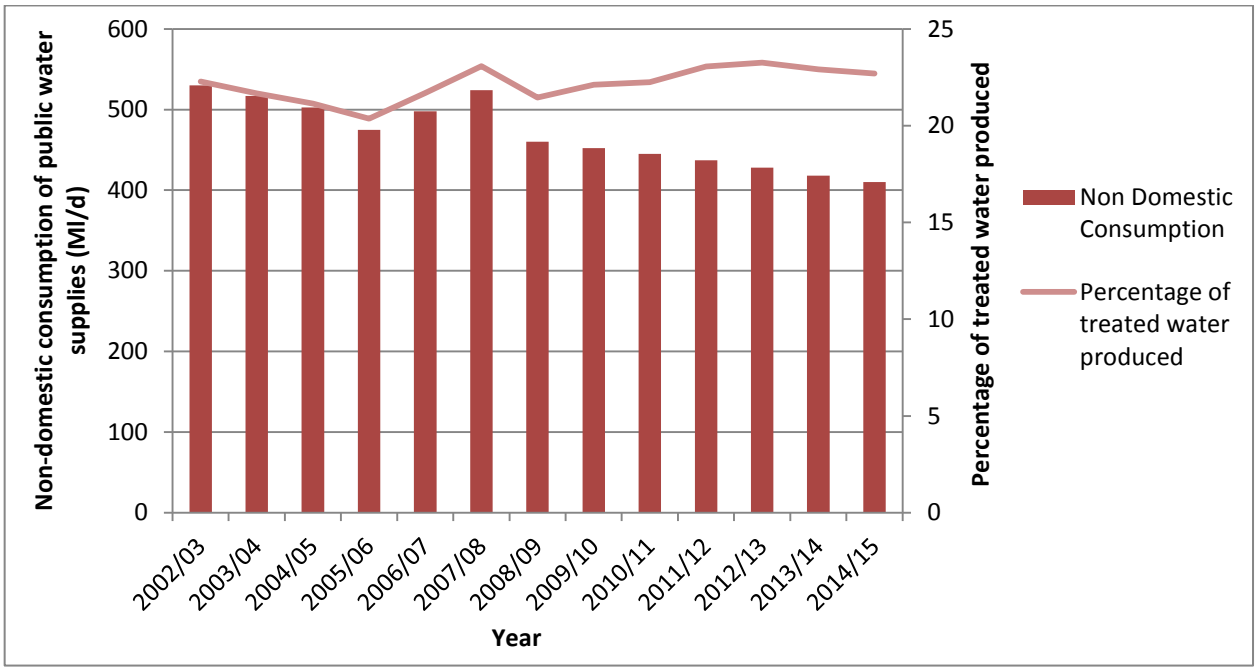
[234] WRAP (2014) *Federation House Commitment Progress Report 2014*. http://www.wrap.org.uk/content/food-and-drink-manufacturing-water-use-progress-reports

[235] Scotch Whisky Association (2015). *Environmental Strategy Report 2015*. http://www.scotch-whisky.org.uk/news-publications/publications/documents/environmental-strategy-report-2015/#.V0QkPPkrJ1s and Scotch Whisky Research Institute (2011) for the Scotch Whisky Association. *Scotch Whisky Industry.* http://www.adaptationscotland.org.uk/12/52/295/Scotch-Whisky-Industry.aspx

[236] Ibid.

[237] Scottish Water. *Annual Returns to Water Industry Commission for Scotland*. http://www.watercommission.co.uk/view_Regulatory_data.aspx

Figure 4.10: Non-domestic consumption of public water supplies, 2002/03 to 2014/15



Source: ClimateXChange indicator BW9. Scottish Government (2015) Key Environmental Statistics 2015.

Analysis shows that the current risk of water scarcity for businesses in Scotland is low.[238] The catchments in Scotland with the largest absolute natural available resource (water available for human use once ecological flow requirements are satisfied) during times of low flows are the Rivers Tay and Spey. The catchments in Scotland with the least absolute natural available resource during times of low flows tend to be small, coastal catchments, although there are a few which are larger and more central. It would be useful to assess whether there are clusters of water-intensive industries in these areas.

RECOMMENDATION 22: The Scottish Environment Protection Agency should begin, by the end of 2017, to publish annual data on water abstraction by industry (separately from agriculture and energy generation) so vulnerabilities can be assessed and managed over time.

RECOMMENDATION 23: The Scottish Government should, before the next SCCAP, set out how the 'Scotland the Hydro Nation' programme incorporates SEPA's national water scarcity plan.

[238] HR Wallingford, Centre for Ecology and Hydrology, British Geological Survey and Amec Foster Wheeler (2015) *CCRA2: Updated Projections for Water Availability for the UK: Final Report for the Adaptation Sub-Committee*. https://www.theccc.org.uk/publication/climate-change-riskassessment-ii-updated-projections-for-water-availability-for-the-uk/

4.4 Conclusions on the SCCAP objectives

The table below summaries progress against the objectives listed within the SCCAP for the Society theme. As the SCCAP does not cover climate change adaptation for businesses, the commentary below does not discuss progress in this area. For the majority of policies and proposals across themes, the SCCAP itself did not define specific enough actions to assess whether the objectives have been achieved. The information contained within the Scottish Government's May 2015 and 2016 annual progress reports were useful in clarifying the actions. The status of individual policies and proposals (as completed, on track, revised or delayed, and dropped) were self-reported by their owners in the relevant government departments and delivery agencies, and presented in the May 2016 progress report.[239]

SCCAP objectives	Commentary
S1-Understand the effects of climate change and their impacts on people, homes and communities.	There are seven policies and proposals that support this objective. The majority of these (six) were reported to be 'completed' or 'on track' and none were reported as 'revised or delayed'. The policies and proposals cover understanding the effects of climate change across broad range of subjects. This includes changes in food related pathogens, flooding impacts on vulnerable communities and generic improvement of the evidence base for emergencies and operational decision making. The reasons for choosing these areas are unclear, in particular whether a gap analysis has been completed across the board on policy areas that affect people, homes and communities to consider where the additional understanding is required.
S2-Increase the awareness of the impacts of climate change to enable people to adapt to future extreme weather events.	There are 15 policies and proposals that support this objective. As well as referring to Adaptation Scotland's work programme and maintaining up to date information on the public facing 'Ready Scotland' website, there are policies to communicate specific information to the public about building regulations and energy efficiency. Progress is taking place in implementing events and providing toolkits. In the May 2016 progress report three policies were reported to be 'completed', 12 as 'on track' and none were 'revised or delayed'. However, as noted in the chapter an evaluation is required to assess what impact these policies are having on increasing awareness.

[239] The number of responses provided was in some cases greater than the total number of SCCAP policies and proposals due to responses being received from several policy teams.

SCCAP objectives	Commentary
S3-Support our health services and emergency responders to enable them to respond effectively to the increased pressures associated with a changing climate.	There are 15 policies and proposals that support this objective, all of these were reported to be 'on track'. These cover policies for supporting the NHS Estate to adapt to climate change such as carrying out flood risk assessments; however the SCCAP does not refer to policies that consider longer term impacts on people that could put extra pressure on the services provided by the health and social care sector. The SCCAP also refers to developing guidance and training for emergency responders for extreme weather. However, as with the other objectives above, it is not known what effect these actions are having on resilience to current or future extreme weather events.

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