



Progress in preparing for climate change

2015 Report to Parliament

Committee on Climate Change
June 2015



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Committee on Climate Change
June 2015

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The Adaptation Sub-Committee



Lord John Krebs, Chair

Professor Lord Krebs Kt FRS FMedSci ML is currently Principal of Jesus College Oxford. He will retire from the Principalship at the end of June 2015. Previously, he held posts at the University of British Columbia, the University of Wales, and Oxford, where he was lecturer in Zoology, 1976-88, and Royal Society Research Professor, 1988-2005. From 1994-1999, he was Chief Executive of the Natural Environment Research Council and, from 2000-2005, Chairman of the Food Standards Agency. He is a member of the U.S. National Academy of Sciences. He was chairman of the House of Lords Science & Technology Select Committee from 2010 to 2014 and President of the British Science Association in 2012.



Professor Samuel Fankhauser

Professor Samuel Fankhauser is Co-Director of the Grantham Research Institute on Climate Change and Deputy Director of the ESRC-funded Centre for Climate Change Economics and Policy, both at the London School of Economics, and a Director at Vivid Economics. He is a former Deputy Chief Economist of the European Bank for Reconstruction and Development.



Professor Jim Hall

Professor Jim Hall FREng is Director of the Environmental Change Institute at Oxford University where he is Professor of Climate and Environmental Risks. A chartered engineer by background, Prof Hall has pioneered the use of probabilistic methods in flood risk assessment and water resource systems. He is Associate Editor of the Journal of Flood Risk Management and Fellow of the Institution of Civil Engineers.



Professor Dame Anne Johnson

Professor Dame Anne Johnson DBE FMedSci is a public health doctor. She is Professor of Infectious Disease Epidemiology and Chair of the Population and Lifelong Health Domain at University College London and Vice-Dean for External Relations, Faculty of Population Health Sciences, UCL. She was a member of the UCL/Lancet Commission report on managing the health effects of climate change. She was previously Chair of the Medical Research Council Population Health Sciences Group. She is a Wellcome Trust governor.



Professor Martin Parry

Professor Martin Parry OBE is a visiting Professor at Imperial College and was Co-Chair of Working of Group II (Impacts, Adaptation and Vulnerability) of the Intergovernmental Panel on Climate Change's (IPCC) 2007 Assessment Report. He was chairman of the UK Climate Change Impacts Review Group, and a coordinating lead author in the IPCC first, second and third assessments. He has worked at the Universities of Oxford, University College London, University of Birmingham and University of East Anglia.



Sir Graham Wynne

Sir Graham Wynne is a former Chief Executive and Director of Conservation of the RSPB. He is currently a Senior Adviser to the Prince of Wales' International Sustainability Unit (ISU), a member of the Board of the Institute for European Environmental Policy and a Trustee of Green Alliance. He was a member of the Policy Commission on the Future of Farming and Food, the Sustainable Development Commission, the Foresight Land Use Futures Group and England's Wildlife Network Review Panel. His early career was in urban planning and inner city regeneration.

Overview

Climate change is expected to alter UK weather conditions and increase the frequency and severity of extreme events. Flooding, heatwaves and periods of drought are projected to become more common. There may also be some opportunities, such as longer growing seasons for agricultural crops. Adapting to climate change will reduce the impacts of future changes and make the most of the opportunities that may arise.

Some changes to the UK climate are already being observed. Air and sea temperatures have risen globally as well as in northern Europe. Sea levels are now on average 16 centimetres higher around the UK coastline than they were at the end of the 19th century. There is also evidence that some weather extremes are already more likely as a result of historic greenhouse gas emissions and the warming of 0.8°C that has occurred to date.¹

The most important response to climate change is to reduce global greenhouse gas emissions, in order to limit overall global warming to no more than 2°C. But some further changes in the climate are inevitable, and there remains significant uncertainty in the magnitude of future warming and its impacts. Depending on the sensitivity of the climate to increasing concentrations of greenhouse gases, and the effectiveness of worldwide efforts to reduce emissions, global average temperatures could be 2 to 5.5°C higher by the end of the century than at the time of the industrial revolution. Nearly all nations, including the UK, recognise that rises in global average temperatures of more than 2°C brings increasing risk of harmful, adverse effects.

Therefore, it is critical that appropriate and cost-effective steps are taken to prepare and adapt the country to climate change. The 2008 Climate Change Act requires the UK Government to conduct a Climate Change Risk Assessment² and, in light of the risks identified, develop a National Adaptation Programme (NAP).³ The Committee on Climate Change is tasked under the Act to assess every two years the progress being made by the NAP. Following the launch of the National Adaptation Programme in 2013, this is the first progress report to Parliament on the NAP's implementation. It has been prepared by the CCC's Adaptation Sub-Committee, building on the ASC's non-statutory progress reports published over the last five years.⁴

The National Adaptation Programme

The Government's National Adaptation Programme presents a number of broad objectives, a summary of relevant policies, and a long list of actions, to prepare the country for climate change. To build on this start, we recommend the next iteration of the NAP should be a more strategic, focused document. It should provide a clearer sense of priorities, set more specific and measurable objectives, and present comprehensive plans and policies to achieve them.

The National Adaptation Programme covers twenty-four focus areas across six main themes: the built environment, infrastructure, healthy and resilient communities, agriculture and forestry, the natural environment, and business. A cross-cutting chapter on local government is also included. This evaluation follows the same structure as presented in the NAP.

¹ Intergovernmental Panel on Climate Change (2014) *Fifth Assessment Report*, <https://www.ipcc.ch/report/ar5/>

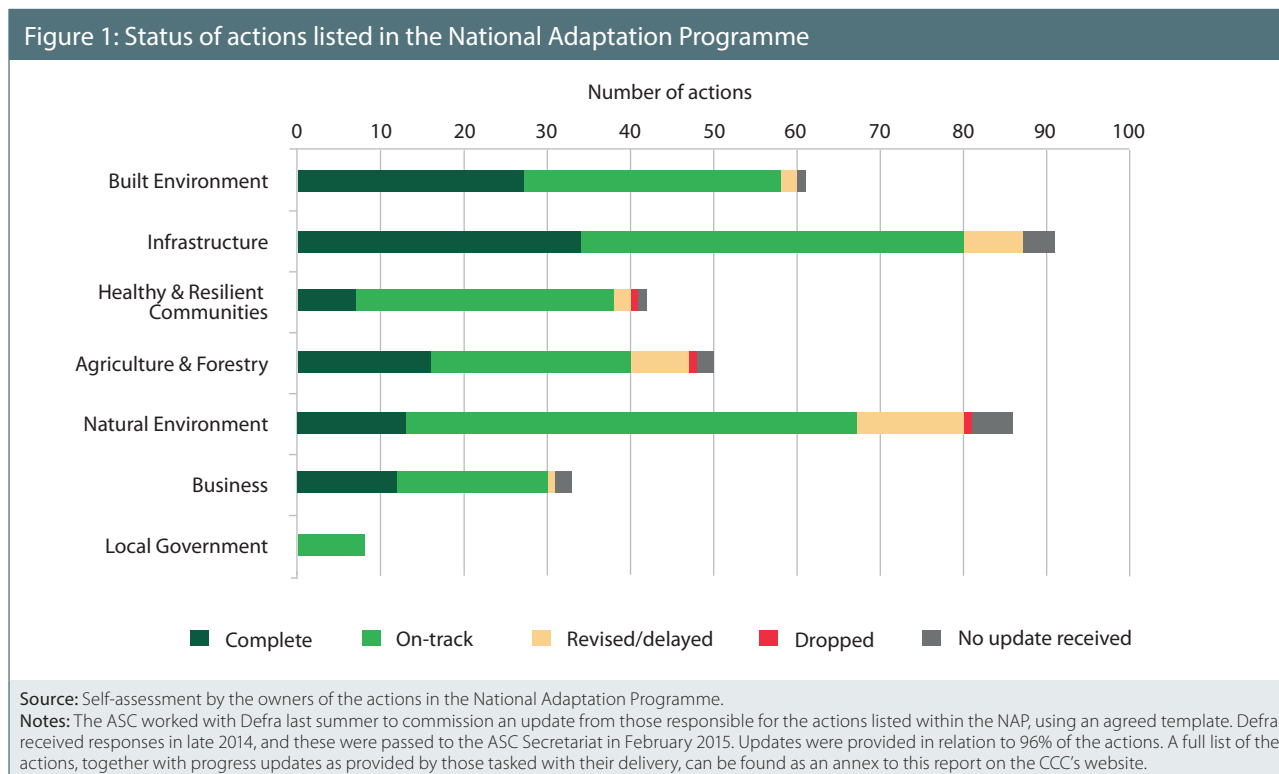
² HM Government (2012) *UK Climate Change Risk Assessment: Government Report*, www.gov.uk/government/publications/uk-climate-change-risk-assessment-government-report

³ HM Government (2013) *National Adaptation Programme, making the country resilient to a changing climate*, www.gov.uk/government/publications/adapting-to-climate-change-national-adaptation-programme. The NAP is primarily concerned with England, with separate adaptation plans and strategies in Scotland, Wales and Northern Ireland.

⁴ Most recently: ASC (2014) *Managing climate risks to well-being and the economy*, <http://www.theccc.org.uk/publications/>

As required by the Act, the Government set a series of objectives to be achieved in preparing for climate change: 31 objectives across the seven main chapters. A total of 371 actions owned by a range of different organisations are listed in an annex to the main document. Objectives and actions were identified through a process of co-creation with stakeholders.

The ASC worked with Defra last summer to commission progress updates from each of the organisations with actions listed in the NAP. Figure 1 shows that almost all of the actions are either complete or considered by those responsible to be on-track.



It is encouraging that so much activity has been taking place across so many organisations with a part to play in climate change adaptation. However, the first NAP did not contain any significant new proposals nor lead to any resources being reprioritised. A lack of specifics makes assessing progress against the objectives, and the impact of the actions being taken, difficult. Many of the remaining actions do not have a fixed timescale for delivery.

The Government's own guidance on policy making states that all policies, programmes and projects should be subject to comprehensive but proportionate evaluation where practicable. In most cases the updates we received did not include evidence of whether, and to what extent, actions are helping to achieve the NAP's objectives. Without routine monitoring and evaluation, it will not be possible to know whether the policies are having the desired effect and any money is being well spent.

We therefore recommend that the next iteration of the National Adaptation Programme should:

- **Set clear priorities for adaptation:** to make sure the most important and urgent issues are being addressed.
- **Ensure objectives are specific, outcome-focused, and measurable:** objectives should describe priority outcomes rather than centre on processes and activities.
- **Focus on the core set of policies and actions that will have the biggest impact:** each with specific goals, responsibilities and timing.

- **Build on the breadth of local community and business engagement in the first NAP:** to reflect regional differences in climate change impacts, and so that local organisations and interests continue to play a role in delivery.
- **Introduce effective monitoring and evaluation:** to allow progress to be measured and effort increased if need be to ensure objectives are being achieved.

Approach to evaluating progress

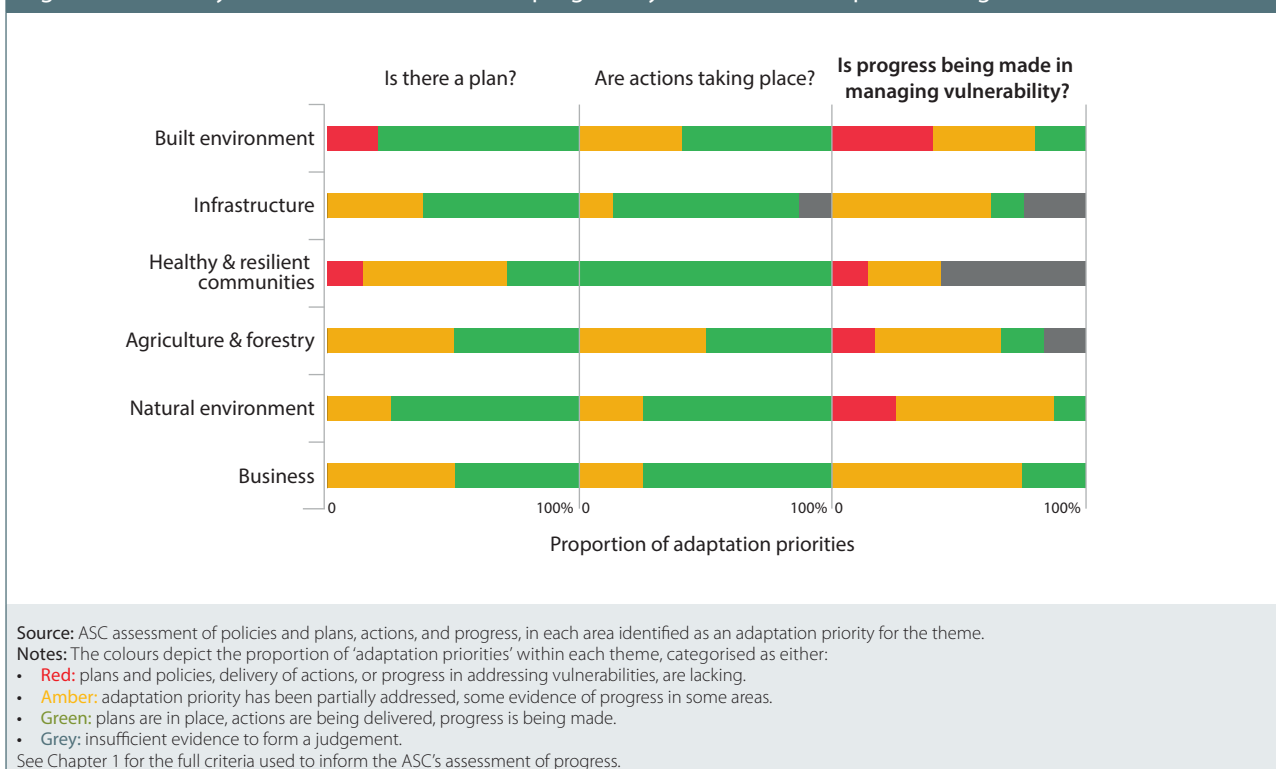
Plans and policies that support climate change adaptation are well-established in many areas. Almost all of the NAP's 371 actions are reported to be complete or on-track. However, this does not necessarily mean that the country's vulnerability to risks from climate change is reducing. Climate change will add to, and exacerbate, pressures arising from population growth, demographic change, and degradation of the natural environment. Policies and actions may be inadequate, or insufficiently coordinated, to counter the increasing risks and make a measurable difference at the national level.

To evaluate the progress being made by the National Adaptation Programme, the Adaptation Sub-Committee 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 area address the relevant climate risks. For example, the National Planning Policy Framework explicitly considers climate change and provides a basis for planning decisions that account for current and future flood risks.
- **Are actions taking place?** As well as assessing whether the actions the Government listed in the National Adaptation Programme are being delivered, the ASC has also reviewed other relevant activity that may be helping to reduce the impacts of climate change.
- **Is progress being made in managing vulnerability?** To arrive at an overall assessment, the ASC has considered the available data to conclude whether vulnerabilities to climate change risks are increasing or decreasing. Thirty-six specific, time-bound, recommendations are made where further progress is felt to be most important.

Figure 2 shows that across the six main themes of the NAP, in many priority areas, plans and policies are in place, and actions have either been completed or are on track (shown in **green**). Despite this, our analysis suggests vulnerability in some areas is increasing (shown as **red** in third column), or that evidence of progress is mixed (shown as **amber**). Areas are highlighted in grey if there is insufficient data to form a judgement.

Figure 2: Summary of the ASC's assessment of progress by the National Adaptation Programme



It is notable that more areas are shown as red in the third column than in the first and second columns. This is because our assessments in the first two areas only consider whether plans and policies that account for climate change exist, and whether actions as stated in the NAP or elsewhere are being delivered. The ratings are not based on whether policies and plans, and actions, are adequate. The third column is therefore the most important, as it is this element of the evaluation that considers whether the National Adaptation Programme is leading to a reduction in vulnerability to climate change risks.

Areas highlighted in grey in the third column are also concerning, as this means vulnerabilities could be increasing but there is insufficient evidence to know either way. This is particularly evident for the healthy and resilient communities theme.

Progress in addressing the key climate change risks

The National Adaptation Programme is required to put in place objectives, proposals and policies to address the risks and opportunities highlighted by the Climate Change Risk Assessment. We have looked across the themes of the NAP to consider the extent to which four key areas of risk identified in the CCRA are being addressed. These are areas where the magnitude of climate change impacts is potentially the greatest and, even where progress is being made, the scale of the challenge means effort will need to be sustained for many decades.

The four key areas of climate risk considered in this section are:

- **Water scarcity:** population growth will increase the demand for water whilst climate change is projected to lead to less water being available to abstract from the environment.
- **Flood risk:** climate change is expected to lead to further sea level rise around the UK coastline. Increases in peak river flows and heavy rainfall will increase inland and urban flood risk.

- **Heat stress:** higher average and peak summer temperatures threaten to increase the number of heat-related deaths within the growing, ageing population.
- **Impacts on natural capital and agriculture:** the combined risks of water scarcity and increasing temperatures will add to existing pressures on the natural environment and agricultural production. Opportunities for increasing yields from agriculture and forestry exist, but only if not constrained by the availability of water and the fertility of soils.

Water scarcity

There has been some reduction in the demand for water, reducing the pressure on already scarce water resources in some parts of England. More people have stronger incentives to use water efficiently, as a result of increasing metering of household water use and the Environment Agency's review of abstraction licences in water-stressed areas. However, upwards pressure on demand continues due to population growth. Structural reform of the water licencing regime is necessary, to promote the right combination of price and regulatory signals during dry periods. Climate change will also necessitate further strategic investments by water companies.

Water resources management plans require water companies to manage the risk of water shortages, taking climate change and population growth in to account. The economic regulator, Ofwat, has approved further investments by water companies over the next five years in the security of water supplies. Changes have also been made to the system of water company penalties and incentives to safeguard drinking water supplies and the treatment of waste water during times of flooding and drought. Almost half of all households now have their use of water measured with a meter. Consumption per person amongst this group is falling. Building regulations are setting high standards for water efficiency in new homes and developers often exceed these.

However, significant decisions in terms of new water storage, treatment and supply infrastructure will need to be taken. Reforming the water abstraction licencing regime also remains an urgent priority. This is necessary to ensure water is allocated efficiently between different industries and sectors whilst safeguarding the natural environment. The Government is due to announce its plans for abstraction reform early in this Parliament. There remains significant scope to manage water in a more efficient and integrated way in the urban and rural environments at the catchment scale.

Flood risk

An increased risk of flooding, including from rivers, the sea, and sewers, was the largest risk identified in the CCRA. The Government invested £2.55 billion to manage flood and coastal erosion risks in England over the last four-year spending period (April 2011 to March 2015). As a result, around 180,000 households now benefit from new or refurbished defences, exceeding the 145,000 target. Investment in flood and coastal defence assets will need to steadily increase in the future to counter the impacts of climate change. Concerted efforts will also be needed by local authorities and partner organisations to improve the management of catchments, the coast, and urban areas in ways that alleviate the potential for flooding.

Even in the best case scenario, with sustained increases in spending at optimal levels over many years, 45,000 more homes and other properties are expected to fall in to the highest flood risk category by mid-century (i.e. at a 1-in-30 annual chance of flooding or greater). Planning policy is ensuring that three-quarters of new development in the floodplain is located in low risk areas. However, each year 1,500 new homes are built in areas of high flood risk and 3,100 homes per year in areas of medium flood risk (at a 1-in-100 annual chance of flooding or greater). New development will add to future flood protection costs and result in flood events causing more damage.

Plans to subsidise flood insurance represent poor value for public money unless, as part of the 'Flood Re' scheme, high risk households are given the information they need to make informed choices and prompted to take action to prevent flood damage. More needs to be done by local authorities to manage the risk of surface water flooding from heavy rainfall, including by requiring the use of sustainable drainage systems (SuDS) and enforcing controls on the use of impermeable surfacing. Local flood risk management strategies have yet to be finalised by most local authorities despite this being a legal requirement for the last five years.

Heat stress

Impacts on health from higher temperatures are likely to increase in the future due to climate change combined with a growing, ageing population. The risk of a severe heatwave is recognised in the National Risk Register. The Heatwave Plan for England provides guidance to health and social care organisations on protecting vulnerable people. However, action is needed to begin to adapt the built environment, so that homes and other buildings can be comfortable and safe in higher temperatures. Recent losses in urban greenspace should also be reversed.

The number of heat-related deaths is projected to increase, from 2,000 per year currently to 7,000 per year by the 2050s, due to increasing mean temperatures and changes in the population. Around 20% of homes may already be overheating, even in relatively cool summers. Combined approaches to improving the energy efficiency of buildings whilst also avoiding overheating are needed, including incentives to encourage passive cooling (e.g. sun shades and improved ventilation). A standard or regulation is needed to avoid the risk of excessive internal temperatures in new homes. Around 7% of the area of urban greenspace in England, important to counter the urban heat island effect, has been lost since 2001. Although the trend in losses has slowed, it has not yet stopped. The Government should adopt a goal to increase urban greenspace and work with local authorities to achieve it.

There is low awareness amongst the general public about how the risks from heat are changing. The majority of people in a recent survey were unaware that the number of hot summer days in the UK has increased, and that hot weather and heatwaves are likely to increase with climate change. The next iteration of the NAP should contain specific actions to increase public awareness of the risks of climate change, with lead responsibility for increasing awareness assigned to a single department.

Impacts on natural capital and agriculture

Some aspects of the natural environment are improving. This will reduce the impacts of climate change on habitats and biodiversity. However, key indicators of environmental quality continue to move in the wrong direction, putting at risk vital ecosystem goods and services such as clean air, clean water, and carbon storage. Harmful land management practices persist, particularly on sensitive peat habitats in the uplands. Some of the most productive agricultural land in England is at risk of becoming unprofitable within a generation due to soil erosion and the loss of organic carbon. Without further action, farmers may not benefit from the opportunities of longer growing seasons, and the natural environment will be severely harmed by climate change.

Climate change will add to existing pressures on vulnerable natural systems. These include air and water pollution, habitat loss and fragmentation, and intensive land-use practices. Of particular concern is the ecological condition of the farmed countryside, where key indicators of biodiversity are in long-term decline. Wetland habitats, including the majority of upland areas with carbon-rich peat soils, are in poor condition. The damaging practice of burning peat to increase grouse yields continues, including on internationally-protected sites. The Government has set ambitious targets to improve the ecological condition of important habitats and halt the decline in England's biodiversity. However it is far from certain that these goals will be met.



Agricultural soils are being degraded by intensive farming practices in some areas, with deep ploughing, short rotation periods and exposed ground leading to soil erosion from wind and heavy rain. Although soil erosion risk may be decreasing, the rate of loss is not sustainable as soil can take a hundred years or more to form. Water shortages and drier soil conditions that are likely with climate change puts at risk the profitability of farming in areas like the East Anglian Fens. This has the potential to reduce the productivity of UK farming, leading to an increased reliance on imported food at a time of growing demand worldwide. The Government recognises the issue and there is an ambition for all soils to be used sustainably by 2030. The evidence gathering phase of the soils strategy will draw to a close in 2016 and needs to be followed by an urgent plan of action.

Full evaluation of adaptation priorities

Figure 3 summarises the ASC's full assessment of the current situation in England in light of the key risks identified by the CCRA. The figure highlights a number of adaptation priorities where stronger policies and plans are needed. Our assessment concludes that vulnerabilities are increasing in six specific areas (those shown in the top row of Figure 3) and the evidence of progress is mixed for the majority of adaptation priorities (those in the central row).

The figure draws upon two of the three dimensions of the ASC's evaluation: whether plans are in place, and whether progress is being made in managing vulnerability. Of the two components, it is more important that indicators of vulnerability are falling. However, vulnerabilities may increase in future if the plans and policies that are currently in place are not sufficient to address the risks of climate change.

Figure 3: Adaptation priorities: are plans in place, and is progress being made?

		Is there a plan? 		
		Red	Amber	Green
Is progress being made in managing vulnerability? 	Red	<ul style="list-style-type: none">• Residual flood risk to existing properties	<ul style="list-style-type: none">• Heat-related health impacts• Fertility of agricultural soils• Ecological condition of the farmed countryside	<ul style="list-style-type: none">• Ecological condition of wetland habitats• Surface water flood management
	Amber	<ul style="list-style-type: none">• Public understanding of climate risks	<ul style="list-style-type: none">• Water demand by agriculture• Coherence of ecological networks• Flooding of agricultural land• Business impacts from extreme weather• Business supply chain interruptions• Infrastructure interdependencies	<ul style="list-style-type: none">• Ecological condition of terrestrial habitats, water bodies & marine environment• Extent of priority natural habitats• Agriculture & forestry: innovation/knowledge transfer• Community-scale flood alleviation• Avoid inappropriate development in flood risk areas• Resilience of infrastructure services: including public water supply, road and rail networks• Design and location of new infrastructure• Cold-related health impacts• Business opportunities from climate change
	Green	<ul style="list-style-type: none">• None	<ul style="list-style-type: none">• Water demand by industry	<ul style="list-style-type: none">• Water demand in the built environment• Climatic suitability of tree species• Ecological condition of coastal habitats• Resilience of energy networks to extreme weather

Source: ASC assessment of policies and plans, and progress, in each area identified as an adaptation priority.










Notes: Adaptation priorities have been categorised as follows:

- **Red:** plans and policies do not exist or do not account for climate change, indicators of vulnerability are increasing.
- **Amber:** plans and policies partially address climate change risks, indicators of vulnerability show mixed progress.
- **Green:** plans and policies are in place that account for climate change, indicators of vulnerability are falling.





Box 1 below summarises our assessment in the six areas where vulnerabilities are judged to be increasing, those areas highlighted in the top row of Figure 3. Box 1 also highlights the seven areas in which we found insufficient evidence to determine whether or not vulnerability is increasing. We will continue to work with the relevant organisations to build datasets and compile evidence to be able to form a judgement in time for our next progress report.

Box 1: Adaptation priorities where vulnerabilities are increasing, or there is insufficient evidence to judge

The following table presents a summary of why adaptation priorities have been assessed as either **red**, where vulnerabilities to climate change impacts are increasing, or **grey**, where we found insufficient evidence to make a judgement. It should also be noted that across the chapters, many adaptation priorities assessed as 'amber' have only partial information available and more evidence would be valuable.

Adaptation priority	Is progress being made in managing vulnerability?	Rationale
Built environment		
Residual flood risk to existing properties		Even in the best case scenario, 45,000 more homes and other properties are expected to fall in to the highest flood risk category by the 2060s. The pace of fitting property-level flood protection measures is slow, and subsidising flood insurance will remove the financial incentive for flood alleviation by high risk households.
Surface water flood management		Trends in urban infill development and impermeable surfacing are likely to be increasing surface water flood risk. Measures to promote SuDS have been weakened. Local authorities are making slow progress in developing local flood risk management strategies.
Built environment / healthy and resilient communities		
Heat-related health impacts		Vulnerability to the impacts of heat is increasing, including as a result of the growing, ageing population. Policies to increase air tightness and the insulation of homes could increase the risk of overheating unless steps are taken to avoid this.
Resilience of infrastructure services		
Ports and airports		There is very little data on the impacts of severe weather on ports and airports and the scale of action being taken in response.
Digital infrastructure		IT, communications, and data processing and storage operations, should be inherently resilient, but there is no evidence from the industry or from the Government to support this assertion.
Healthy and resilient communities		
Pathogens, air pollution, and UV radiation		It is difficult to assess how the combined effects of climate change, demographic change, behaviour of the population, and changes in land use, are altering exposure to these hazards.
Capability of the health and social care system		There is no data currently available on what magnitude of extreme weather is being planned for by service providers, and what specific measures individual health and social care providers are putting in place to manage risks.
Capability of the emergency planning system		Information is lacking on capabilities and levels of local resilience to extreme weather events. There has been no assessment of the overall impact on emergency service capabilities from declining resources, and there is no independent scrutiny of local plans.
Capacity of people and communities to recover from flooding		There is little evidence of the long-term impacts on individuals' health and well-being arising from flood events. It is also not possible to assess whether the steps being taken will mean people will be able to recover from flooding more quickly in future.

Box 1: Adaptation priorities where vulnerabilities are increasing, or there is insufficient evidence to judge

Agriculture and forestry		
Fertility of agricultural soils		Soil organic carbon levels are deteriorating nationally in arable soils. Lowland peat soils continue to be lost and degraded, putting at risk some of England's most productive agricultural land.
Prevalence of new and existing pests and diseases		The effects of climate change on the incidence of specific pests and diseases in England are highly uncertain.
Natural environment		
Ecological condition of wetland habitats		Progress in restoring wetland habitats is off course against the targets set in the Biodiversity 2020 strategy. Peatlands are releasing carbon dioxide to the atmosphere, and in the form of dissolved organic carbon to water bodies.
Ecological condition of the farmed countryside		Despite growth in agri-environment schemes, most long-term indicators show continuing declines in species diversity in the farmed countryside.

In addition, the level of action relating to the digital infrastructure sector has also been assessed as 'grey'. The NAP does not contain any specific actions relating to digital infrastructure, despite information and communications technologies being critical to support infrastructure services and the economy more broadly.

Notes: See individual chapters of this report for more details.

Priority recommendations for further progress

In this report, we make 36 recommendations to promote the pace and scale of climate change adaptation. Table 1 presents the most important of these, to help the Government prioritise areas for further intervention.

The recommendations below relate to those adaptation priorities where the progress in managing vulnerability has been given a 'red' rating. The full list of 36 recommendations, organised by NAP theme, can be found at the end of this overview chapter.

Table 1: Priority recommendations	
Adaptation priority	Recommendation
Residual flood risk to existing properties	2. Defra should take steps to address the increasing number of homes and other properties expected to be at high flood risk in the coming decades, publishing a strategy within a year of this report. Full use should be made of the opportunities presented by the Flood Re subsidised insurance scheme to encourage households in high flood risk areas to take steps to reduce the potential for flood damage.
	7. Flood Re's transition plan, required within three months of Flood Re Ltd. being formally designated the scheme administrator, should include clear proposals for how the scheme will promote flood risk alleviation amongst high risk households.
Heat-related health impacts	15. DCLG should, before the ASC's next report in 2017, evaluate the latest evidence and subsequently introduce a new standard or regulation on reducing the risk of overheating in new homes.
	16. DCLG and the Department of Health should develop incentives for the uptake of passive cooling in existing homes, hospitals and care homes and include new measures in the next NAP.
	17. DCLG should adopt and deliver a goal of reversing the decline in urban greenspace, and work with local authorities to begin delivering an implementation strategy by the time of the ASC's next report in 2017.
Fertility of agricultural soils	23. Defra should take action to deliver its policy aspiration for all soils to be sustainably managed by 2030, publishing an action plan within a year of this report to describe how the goal will be achieved. The action plan should include proposals for establishing a scheme to monitor the uptake of soil conservation measures, with enforcement where soils are not being appropriately managed. The action plan should include specific proposals to reverse the on-going loss of lowland peat soils, and be developed in partnership with the farming sector.
Ecological condition of the farmed countryside	29. Natural England should establish within a year of this report a monitoring scheme to assess the extent to which the new Countryside Stewardship scheme will help to deliver coherent ecological networks, and more broadly reduce the vulnerability of farmland wildlife to environmental pressures, including climate change.
Ecological condition of wetland habitats	27. Natural England, in partnership with the Upland Stakeholder Forum, should take further action to deliver the widespread restoration of degraded upland peat habitats. An action plan should be published within a year of this report that includes: (a) a programme for reviewing consents for burning on protected sites; and (b) an assessment of the extent to which agri-environment schemes are being used to fund damaging practices on peatland habitats.
Surface water flood management	3. Defra should (a) amend in this Parliament the 1991 Water Industries Act in order to remove or make conditional the current automatic right to connect new development to public sewers and (b) work with local government representatives to improve local flood risk management arrangements. Both elements should be part of an action plan to tackle surface water flood risk, to be published by Defra within a year of this report.

- | | |
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| | <p>4. DCLG should by the time of the ASC's next report in 2017 (a) make water companies statutory consultees on all planning applications that have implications for the public sewer network; (b) put in place a process for monitoring and evaluating the effectiveness of planning policy in (i) achieving a high uptake of SuDS in new development and (ii) limiting the paving-over of front gardens with impermeable surfaces.</p> <p>5. Ofwat should require each water company to report on the area of land where above-ground SuDS, including permeable paving, has been installed over the current Asset Management Plan (AMP) period to 2020, as part of delivering the industry-wide commitment to reduce sewer flooding incidents by 33%.</p> |
|--|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Cross-cutting issues

Our review has also found a number of cross-cutting issues, common to many NAP themes (Box 2).

The next iteration of the National Adaptation Programme should address these issues in order to develop coherent policies, promote effective action, and maximise the wider benefits of adaptation.

Box 2: Important cross-cutting issues for the next National Adaptation Programme

Fragmentation of policies on the main climate risks. Two of the main risks from climate change identified in the CCRA were the risk of flooding and water scarcity. The thematic nature of the NAP means that policies and actions to address these risks are spread across many chapters. This makes it difficult to understand whether the actions taking place are sufficient to deal with the risks and how interdependencies between the themes are being managed. For example, there is scope for greater integration in how water is managed in the built and natural environments, to encourage re-use and improve water quality without the need for treatment. Coordinated approaches to alleviate both the risk of flooding and water scarcity at the catchment scale may be possible in some parts of the country.

Coherence between mitigation and adaptation policies. There are a number of areas where there are co-benefits from, or trade-offs between, reducing greenhouse gas emissions and adapting to climate change. For example, there is the potential to retrofit the housing stock so that homes retain heat in the winter whilst avoiding excessive heat gain in the summer. There are synergies between adaptation and mitigation in the built environment (e.g. green infrastructure), in agriculture and forestry (e.g. soil conservation), infrastructure (e.g. water demand for lower carbon energy technologies), and in the natural environment (e.g. carbon sequestration). Currently, these links are not being fully reflected in government policy which could be leading to missed opportunities and maladaptation.

Importance of strategic planning. The cumulative impact of individual decisions on new development and national infrastructure could be building-up systemic risk. There is a need for a more strategic assessment of land-use at a national and sub-national level to guide where new development and infrastructure should be located.

Intervention at the relevant spatial scale. The risks of climate change and their impacts will vary across England. Policies should therefore take a spatially-relevant approach to determine where and how to intervene. In some cases this requires coordination at a national level, but often it requires effective action at regional and local levels. The next NAP could include a spatial dimension; one that considers the different risks, priorities, and policy requirements in different parts of England.

Box 2: Important cross-cutting issues for the next National Adaptation Programme

International dimensions. A recent report by PwC for Defra concluded that the international risks and opportunities to the UK from climate change could be an 'order of magnitude' larger than those originating within the UK. The research highlights the need to consider the international dimensions of climate change impacts. However, international risks received very little attention in the NAP, mainly because the first CCRA focussed on risks and opportunities arising in the UK. The Evidence Report for the second CCRA being produced by the ASC will have a chapter on international risks.

Next steps

Under the Climate Change Act, the Government is required to respond to this progress report by 15th October 2015. The ASC's next major milestone is to present its statutory advice to the Government on the second Climate Change Risk Assessment. This will be published in the summer of 2016, in the form of an Evidence Report. We will also be commissioning further research and analysis in order to inform our next progress report on the National Adaptation Programme in 2017.

Under the Act, the ASC's next statutory report on the National Adaptation Programme is due for publication in June 2017. In the period before this, the ASC is helping the Government to prepare the second Climate Change Risk Assessment. The next CCRA is due to be presented to Parliament by the Government in early 2017. To inform the Government's report, we will publish an independent review of the latest evidence on climate change hazards and their short, medium and long-term implications for the UK. Our advice will take the form of an Evidence Report that will be published in July 2016.

The ASC's next assessment of the National Adaptation Programme in 2017 will look again at the implementation of the actions and objectives listed in the NAP, and the latest data on how trends in vulnerability may be changing. It will also consider whether the recommendations made in this report are being addressed and what outcomes are being achieved as a result.

Full list of recommendations

Table 3 provides the full list of recommendations made in this report, together with their ownership and timing.

Table 3: Recommendations from the first statutory assessment of the NAP				
Chapter/ theme	Adaptation priority	Recommendation	Owner	Timescale
The National Adaptation Programme	n/a	<p>1. The second National Adaptation Programme should:</p> <ul style="list-style-type: none"> • Set clear priorities for adaptation: to make sure the most important and urgent issues are being addressed. As well as this report, the next Climate Change Risk Assessment will help the Government identify the most urgent risks facing the UK from climate change, to provide a clearer focus for the next NAP. • Ensure objectives are specific, outcome-focused, and measurable: objectives should focus on priority outcomes, and what needs to be achieved in real-world terms, rather than describing processes and activities. • Focus on the core set of policies and actions that will have the biggest impact: each with specific goals, responsibilities and timing. It should be clear how each action helps address one or more of the risks identified as requiring urgent attention by the next CCRA. • Introduce effective monitoring and evaluation: that allows progress to be measured and reviewed so that policies can be strengthened and resources reallocated (including between departments) if need be, in order to ensure the objectives are being achieved. 	Defra	Next NAP report in 2018
Built environment	Residual flood risk to existing properties	<p>2. Defra should take steps to address the increasing number of homes and other properties expected to be at high flood risk in the coming decades, publishing a strategy within a year of this report. Full use should be made of the opportunities presented by the Flood Re subsidised insurance scheme to encourage households in high flood risk areas to take steps to reduce the potential for flood damage.</p>	Defra	Summer 2016

Table 3: Recommendations from the first statutory assessment of the NAP				
Chapter/ theme	Adaptation priority	Recommendation	Owner	Timescale
	Surface water flood management	3. Defra should (a) amend in this Parliament the 1991 Water Industries Act in order to remove or make conditional the current automatic right to connect new development to public sewers and (b) work with local government representatives to improve local flood risk management arrangements. Both elements should be part of an action plan to tackle surface water flood risk, to be published by Defra within a year of this report.	Defra	Summer 2016
		4. DCLG should by the time of the ASC's next report in 2017 (a) make water companies statutory consultees on all planning applications that have implications for the public sewer network; (b) put in place a process for monitoring and evaluating the effectiveness of planning policy in (i) achieving a high uptake of SuDS in new development and (ii) limiting the paving-over of front gardens with impermeable surfaces.	DCLG	Early 2017
		5. Ofwat should require each water company to report on the area of land where above-ground SuDS, including permeable paving, has been installed over the current Asset Management Plan (AMP) period to 2020, as part of delivering the industry-wide commitment to reduce sewer flooding incidents by 33%.	Ofwat	2020
	Avoid inappropriate development in flood risk areas	6. DCLG and the Environment Agency should by the time of the ASC's next report in 2017 publish an assessment quantifying the impact of new development on long-term flood risk. The evidence from this assessment should be used to inform subsequent Environment Agency long-term investment scenarios.	DCLG	Early 2017
	Residual flood risk to existing properties	7. Flood Re's transition plan, required within three months of Flood Re Ltd. being formally designated the scheme administrator, should include clear proposals for how the scheme will promote flood risk alleviation amongst high risk households.	Flood Re Ltd	Autumn 2015
	Water demand in the built environment	8. Ofwat should continue to work with the Environment Agency and water companies to ensure that action is being taken to manage household demand for water. This will require ambitious demand reduction commitments in the next round of long-term water resources management plans, due in 2019, including ensuring sustained increases in metering and a continued reduction in average per person consumption.	Ofwat	2019

Table 3: Recommendations from the first statutory assessment of the NAP

Chapter/ theme	Adaptation priority	Recommendation	Owner	Timescale
Infrastructure	Design and location of new infrastructure	9. In time for the ASC's next progress report in June 2017, the Department for Communities and Local Government should develop an approach to assess whether systemic risk is increasing or reducing as a result of individual decisions on the location of new national infrastructure assets. This should inform a decision on whether there is a need for an overarching National Policy Statement to guide decisions on the design and location of new assets.	DCLG	Early 2017
	Resilience of infrastructure services	10. The Cabinet Office should work with all infrastructure sectors as part of the next round of sector resilience plans in 2015 to develop consistent incident reporting, together with indicators of network resilience and performance, to allow improvements to be measured over time. The results should be presented by operators as part of their reports under the third round of the ARP. Reporting as part of the third round of the ARP should be made mandatory.	Cabinet Office	Summer 2016
		11. The Cabinet Office should confirm that the services provided by all critical national infrastructure (CNI) are now resilient to a 1-in-200 year flood event. The Cabinet Office should agree, for a wider range of climate risks, sector resilience standards that are in the national interest and see that they are implemented. This process should inform the 2016 round of sector resilience planning.	Cabinet Office	End of 2016
	Infrastructure interdependencies	12. Information on asset and network resilience should be shared between operators of interdependent assets, and with Local Resilience Forums. The Cabinet Office should facilitate the piloting of secure information sharing arrangements within a year of this report's publication. Based on the results, the Cabinet Office should consider introducing in this Parliament a legal duty to co-operate and share such information.	Cabinet Office	Summer 2016
		13. The UK Regulators Network should ensure that proportionate and cost-effective approaches to increasing resilience and reducing climate change risks are in place for the economically-regulated sectors. A cross-sector review of reward and penalty regimes should be conducted in time for the ASC's next progress report in 2017, to ensure there are sufficient incentives in place for operators to manage severe weather incidents effectively and preserve services where possible.	UK Regulators Network	Early 2017

Table 3: Recommendations from the first statutory assessment of the NAP				
Chapter/ theme	Adaptation priority	Recommendation	Owner	Timescale
Healthy and resilient communities	Public understanding of climate risks	14. The next NAP, due in 2018, should contain a specific set of actions that aim to increase public awareness of climate change risks. Lead responsibility should be assigned to a single Government Department.	Defra	Summer 2018
	Heat-related health impacts	15. DCLG should, before the ASC's next report in 2017, evaluate the latest evidence and subsequently introduce a new standard or regulation on reducing the risk of overheating in new homes.	DCLG	Early 2017
		16. DCLG and the Department of Health should develop incentives for the uptake of passive cooling in existing homes, hospitals and care homes and include new measures in the next NAP.	DoH and DCLG	Next NAP report in 2018
		17. DCLG should adopt and deliver a goal of reversing the decline in urban greenspace, and work with local authorities to begin delivering an implementation strategy by the time of the ASC's next report in 2017.	DCLG	Early 2017
	Capability of the emergency planning system	18. The Cabinet Office should, before the ASC's next report in 2017, undertake a quantitative assessment of the capability of the national emergency planning system to manage extreme weather events; and in light of the findings, publish a summary outlining where further capability may be needed.	Cabinet Office	Early 2017
		19. DCLG should work with Local Resilience Forums to instigate a system that quantitatively assesses local capabilities to respond to extreme weather events, with the results to be made available in time for the ASC's next progress report in 2017.	DCLG	Early 2017
	Capacity of people and communities to recover from flooding	20. Local authorities should routinely collect and publish data on flood recovery, including the length of time occupants have to wait until they are able to return to their homes after a flood event. DCLG should review the capacity of local authorities to support people physically and mentally in the aftermath of a flood, and publish its findings before the ASC's next report in 2017.	DCLG	Early 2017

Table 3: Recommendations from the first statutory assessment of the NAP				
Chapter/ theme	Adaptation priority	Recommendation	Owner	Timescale
Agriculture and forestry	Water demand by agriculture	21. Defra should bring forward its planned review of water efficiency measures on farms to the summer of 2016, in line with the initial plans presented in the National Adaptation Programme.	Defra	Summer 2016
	Flooding of agricultural land	22. Defra, in collaboration with the Environment Agency and others such as the National Farmers Union, the Country Land and Business Association, and the Association of Drainage Authorities, should pilot integrated approaches to managing the risk of flooding to agricultural land. Approaches should incorporate catchment management, best practice farming approaches, and appropriate land drainage and flood defences. This should be completed in time to inform wider dissemination of the lessons as part of the next NAP in 2018.	Defra	Next NAP report in 2018
	Fertility of agricultural soils	23. Defra should take action to deliver its policy aspiration for all soils to be sustainably managed by 2030, publishing an action plan within a year of this report to describe how the goal will be achieved. The action plan should include proposals for establishing a scheme to monitor the uptake of soil conservation measures, with enforcement where soils are not being appropriately managed. The action plan should include specific proposals to reverse the on-going loss of lowland peat soils, and be developed in partnership with the farming sector.	Defra	Summer 2016
	Prevalence of new and existing pests and diseases	24. Defra should use the information contained within the UK Plant Health Risk Register to publish aggregate metrics that enable the overall risk from pests and diseases to be monitored over time. This should be completed in time to inform the ASC's next progress report in 2017.	Defra	Early 2017
	Innovation and knowledge transfer	25. Defra should publish an initial evaluation of the impact of the Agri-Tech Strategy in time to inform the next NAP in 2018.	Defra	Next NAP report in 2018

Table 3: Recommendations from the first statutory assessment of the NAP				
Chapter/ theme	Adaptation priority	Recommendation	Owner	Timescale
Natural Environment	Ecological condition of priority habitats	<p>26. Defra and Natural England should continue to take action to deliver all of the outcomes in the England Biodiversity 2020 strategy and publish within a year of this report a plan setting out how they intend to deliver key goals important for adaptation, namely:</p> <ul style="list-style-type: none"> – improving the condition of priority habitats and protected sites (Outcome 1A); – increasing the extent of priority habitats by 200,000 hectares (Outcome 1B); and – ensuring that 15% of degraded ecosystems important for climate change adaptation and mitigation are being restored (Outcome 1D). <p>The action plan should also provide clarity on the interpretation of ‘favourable ecological condition’ in the context of climate change.</p>	Defra/ Natural England	Summer 2016
	Ecological condition of wetland habitats	<p>27. Natural England, in partnership with the Upland Stakeholder Forum, should take further action to deliver the widespread restoration of degraded upland peat habitats. An action plan should be published within a year of this report that includes:</p> <p>(a) a programme for reviewing consents for burning on protected sites; and (b) an assessment of the extent to which agri-environment schemes are being used to fund damaging practices on peatland habitats.</p>	Natural England	Summer 2016
	Ecological condition of rivers, lakes and estuaries	<p>28. The Environment Agency, Defra and water companies should continue to take action to ensure that water bodies are managed in ways that will increase resilience to the changes in water availability, quality and temperature expected with climate change. To deliver this (a) the Environment Agency should publish within a year of this report the steps it will take to ensure full delivery of the Restoring Sustainable Abstraction programme by 2020, and (b) Defra should press ahead with reforms to the abstraction regime early in this Parliament.</p>	Environment Agency/ Defra	Summer 2016
	Ecological condition of the farmed countryside	<p>29. Natural England should establish within a year of this report a monitoring scheme to assess the extent to which the new Countryside Stewardship scheme will help to deliver coherent ecological networks, and more broadly reduce the vulnerability of farmland wildlife to environmental pressures, including climate change.</p>	Natural England	Summer 2016

Table 3: Recommendations from the first statutory assessment of the NAP

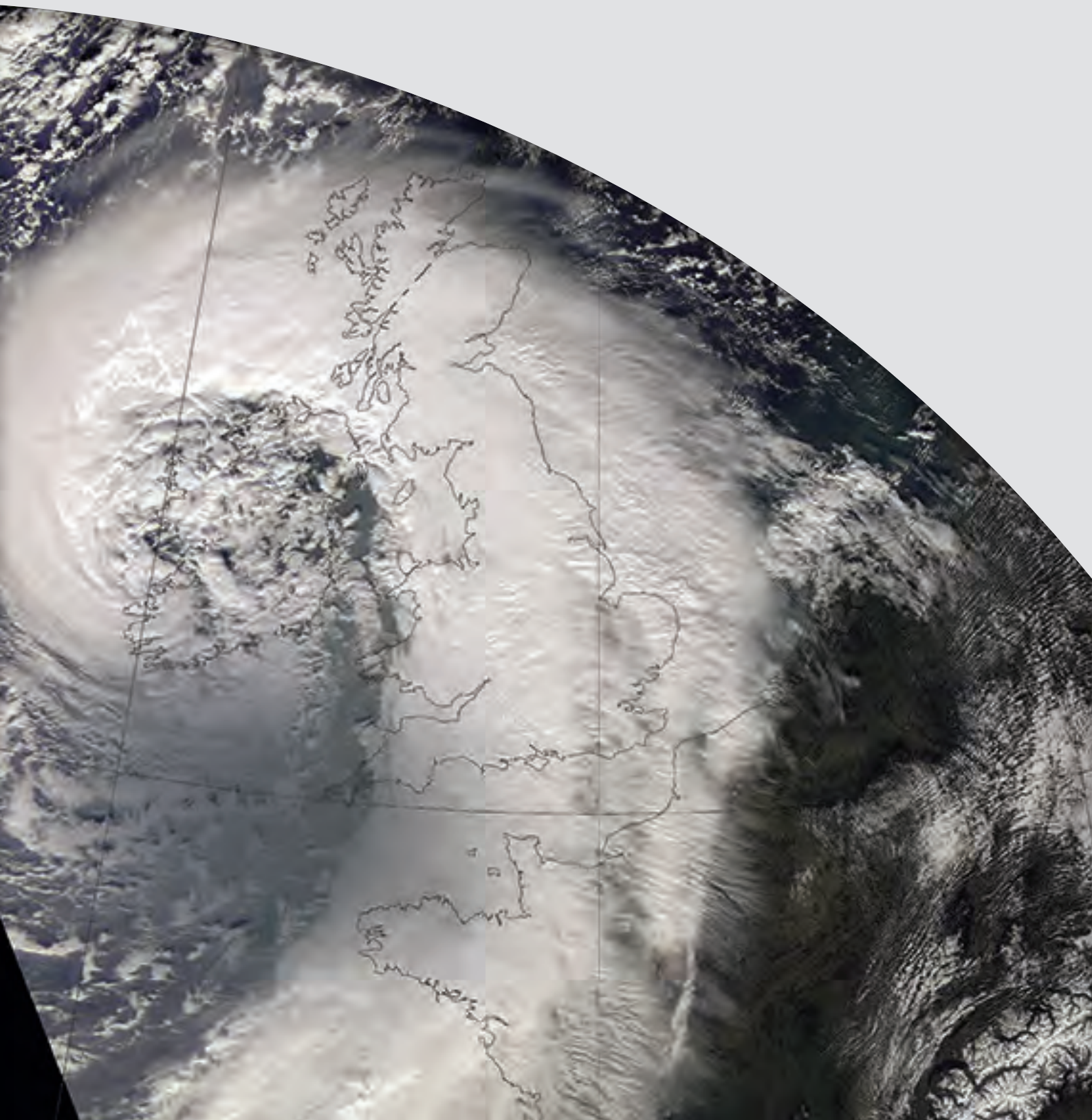
Chapter/ theme	Adaptation priority	Recommendation	Owner	Timescale
	Extent of priority habitats	30. The Environment Agency should continue to take action to ensure there is no net loss of internationally protected coastal habitats by 2025 as a result of coastal squeeze and publish within a year of this report a programme of habitat creation projects they have identified to deliver this goal. The Agency should also report on the progress being made with the implementation of the habitat creation programme in time to inform the ASC's next statutory report in June 2017.	Environment Agency	Summer 2016
Business	Business impacts from extreme weather	31. The Environment Agency should evaluate the impact of the adaptation tools and guidance it has published, including the Climate Ready support service, in time for the ASC's next progress report in 2017. The results of this should be used to identify to what extent businesses at most risk are using the tools and whether there is a need to amend them to better reflect user needs, particularly for SMEs.	Environment Agency	Early 2017
		32. Defra should evaluate the 'Repair and Renew' grant scheme within a year of this report and develop new policies in time for the next NAP due in 2018, to encourage businesses in high risk areas to improve their resilience to flooding and fit property-level flood protection measures where appropriate.	Defra	Next NAP report in 2018
	Supply chain interruptions	33. The Department for Business, Innovation and Skills should assess the case for regulatory and non-regulatory measures and take action to encourage all listed companies to report on their exposure to risks from climate change, and how those risks are being managed. This assessment should be completed in time to inform the next NAP due in 2018.	Department for Business, Innovation & Skills	Next NAP report in 2018
		34. The Bank of England should undertake research to better understand the potential systemic risks from climate change to the finance sector, building on the forthcoming report under the Adaptation Reporting Power by the Prudential Regulatory Authority. The research should be completed in time to inform the next NAP, due in 2018. The third round of ARP reporting should be extended to cover all areas of the finance sector.	Bank of England	Next NAP report in 2018

Table 3: Recommendations from the first statutory assessment of the NAP				
Chapter/ theme	Adaptation priority	Recommendation	Owner	Timescale
	Water demand by industry	35. Defra should develop options in time for the next NAP, due in 2018, to encourage industry to improve water efficiency particularly in water stressed areas. This will help companies to make the transition to the likelihood of tighter restrictions and higher prices for water use during times of water scarcity, under abstraction reform.	Defra	Next NAP report in 2018
Local government	All	36. Defra and DCLG should introduce a cost-effective and proportionate way of assessing the progress being made by local authorities in taking action to reduce the vulnerability of their communities to the impacts of extreme weather. This could be by including local authorities in the next round of the Adaptation Reporting Power.	Defra/DCLG	Summer 2016



Chapter 1: The National Adaptation Programme

- 1.1 The UK adaptation policy cycle
- 1.2 The first National Adaptation Programme
- 1.3 Developing the next National Adaptation Programme
- 1.4 Evaluating progress by the National Adaptation Programme



Key messages

The 2008 Climate Change Act introduced a legal requirement for the Government to prepare an assessment of the risks facing the UK from climate change, and a National Adaptation Programme (NAP) that sets out how those risks will be addressed. The Act also established the Committee on Climate Change (CCC), with an Adaptation Sub-Committee (ASC), to provide Parliament every two years with an independent assessment of progress by the NAP. This is the ASC's first statutory assessment of the NAP.

The NAP was produced through a process of 'co-creation', with stakeholders encouraged by the Government to help write the NAP's objectives and suggest actions that could be delivered. This consultative approach was effective in bringing together a wide range of organisations across the country, reflecting the fact that adaptation is as much a local, as a national, challenge.

Involving stakeholders in creating the NAP has helped to foster action. This is evident with the status of the more than 370 specific actions listed in the programme. The majority have either been completed or are on-track. Only a small proportion have been dropped or delayed. It will be important to ensure that this process of stakeholder engagement continues with the preparation of the second NAP, which is due in 2018.

However, the first NAP could have done more to emphasise the importance of particular risks and objectives, and drive the delivery of priority outcomes at the national and sub-national levels. When compared to the guiding principles for policy making as set out in the HM Treasury's Green Book:

- **The NAP gives little sense of strategic purpose:** it does not make clear which risks are the most important to address, which objectives are the most pressing, or what activity will have the biggest impact.
- **The NAP lists a range of useful activity but does not amount to a coherent programme:** the NAP is primarily a summary of existing policies relevant to adaptation and a snap-shot of activity already underway.
- **Progress is hard to measure:** the objectives in the NAP mostly describe processes rather than setting clear outcomes against which progress can be measured. This has made it difficult to evaluate the effectiveness of the programme.

Based on this assessment, the ASC recommends that the Government makes the following improvements in time for the next NAP due in 2018:

RECOMMENDATION 1: The second National Adaptation Programme should:

- **Set clear priorities for adaptation:** to make sure the most important and urgent issues are being addressed. As well as this report, the next Climate Change Risk Assessment will help the Government identify the most urgent risks facing the UK from climate change, to provide clearer areas of focus for the next NAP.
- **Ensure objectives are specific, outcome-focused, and measurable:** objectives should focus on priority outcomes, and what needs to be achieved in real-world terms, rather than describing processes and activities.
- **Focus on the core set of policies and actions that will have the biggest impact:** each with specific goals, responsibilities and timing. It should be clear how each action helps address one or more of the risks requiring urgent attention, as will be identified by the next CCRA.

Key messages

- **Build on the breadth of local community and business engagement in the first NAP:** in order to ensure the second NAP reflects regional differences in climate change impacts and that local organisations and interests continue to play a role in delivery.
- **Introduce effective monitoring and evaluation:** that allows progress to be measured on a regular basis so that policies can be strengthened and resources reallocated (including between departments) if need be, in order to ensure the objectives are being achieved.

The ASC has developed a systematic approach to evaluating the National Adaptation Programme. As well as the actions in the NAP, the assessment considers other policies introduced since in order to provide a comprehensive assessment of whether key adaptation priorities are being addressed.

1.1 The UK adaptation policy cycle

The UK is one of the first countries to establish a legal framework for adapting to climate change.

The 2008 Climate Change Act was ground-breaking in creating a framework for both mitigating and adapting to climate change. The Act established legally-binding carbon budgets to put the UK on a trajectory to meet an 80% reduction in greenhouse gas emissions by 2050 compared with 1990 levels. The Committee on Climate Change publishes annual progress reports on achieving carbon budgets, with the latest of these published in parallel with this report.

The Act also put in place requirements to prepare the country for climate change and adapt to its impacts. The Government is required to firstly assess the risks and opportunities facing the UK from climate change, and then set out objectives, policies and proposals to address those risks (Figure 1.1).

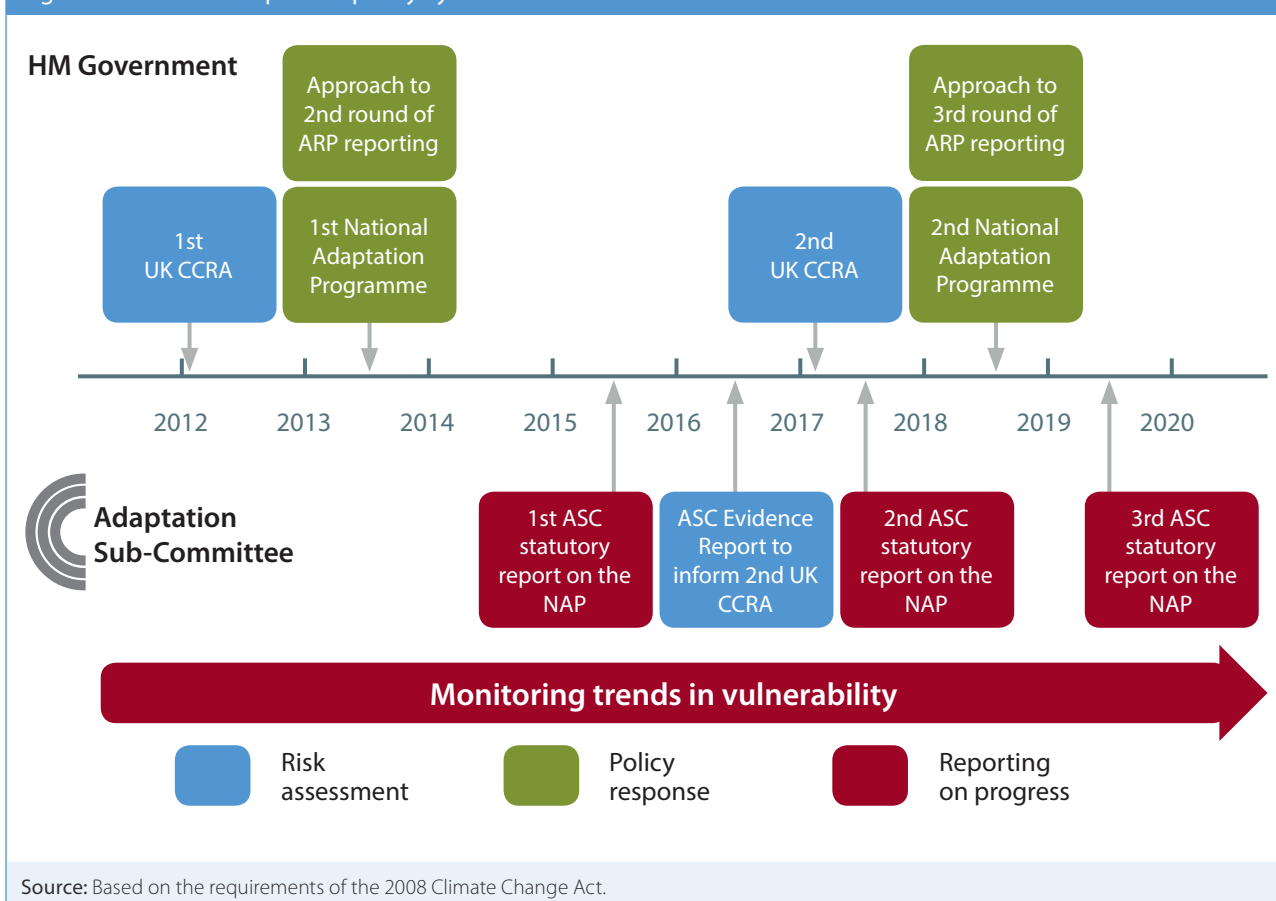
The first UK Climate Change Risk Assessment (CCRA) was published in January 2012¹ and the first National Adaptation Programme in July 2013.² The Act requires this process to be repeated every five years, with the next CCRA due in 2017 and the second NAP in 2018. The NAP covers devolved policy areas for England and reserved matters for the UK. The Act also established a process for organisations to report on the progress they are making with adaptation, known as the Adaptation Reporting Power (ARP). This also operates on a five-yearly cycle, with the Government setting the framework for the next cycle of ARP reporting alongside the publication of each NAP report.

The Committee on Climate Change has responsibility under the Act to report to Parliament every two years with an independent assessment of the progress being made with the implementation of the NAP. The Government is required to provide Parliament with its response to the CCC's progress reports by mid-October. The Adaptation Sub-Committee has prepared this report on behalf of the CCC.

¹ HM Government (2012) *UK Climate Change Risk Assessment: Government Report*, www.gov.uk/government/publications/uk-climate-change-risk-assessment-government-report

² HM Government (2013) *National Adaptation Programme, making the country resilient to a changing climate*, www.gov.uk/government/publications/adapting-to-climate-change-national-adaptation-programme

Figure 1.1: The UK adaptation policy cycle



This cyclical process of assessment, planning and reporting provides an appropriate, iterative approach to managing the uncertainties associated with a changing climate.

Each cycle should build on the previous one. The next CCRA in 2017 should take into account the extent to which the implementation of the current NAP has helped to manage the overall level of climate change risk.

Undertaking national climate change risk assessments every five years should ensure that any changes in climate hazards over time, such as increases in the frequency of flood or drought events, are being identified. Regular assessments will also pick up any trends in exposure and vulnerability to those hazards, for example changes in the number of properties located in areas of flood risk.

This, in turn, will inform the development of appropriate policy responses that reflect any changes in risk. The implementation of these policy responses will also be continually assessed through the ASC's independent scrutiny of progress every two years.

In the last few years, adaptation programmes or strategies for Scotland, Wales and Northern Ireland have also been produced (Box 1.1) to address the risks identified in the CCRA.

Box 1.1: Adaptation programmes in Scotland, Wales and Northern Ireland

Scotland

Under the provisions of the Climate Change (Scotland) Act 2009, Scottish Ministers laid the Scottish Climate Change Adaptation Programme (SCCAP) before the Scottish Parliament in 2014. The SCCAP sets objectives, policies and proposals to tackle climate change impacts on the natural environment, buildings and infrastructure networks, and society. The Public Bodies Climate Change Duties, also established by the Act, requires that Public Bodies exercise their functions in a way that delivers the statutory adaptation programme.

Scottish Ministers have requested that the Adaptation Sub-Committee provide an independent assessment of the SCCAP's implementation. The Committee's report will be published in September 2016.

Wales

The UK Climate Change Act does not require the Welsh Assembly Government to lay a statutory adaptation programme. However, as part of its 2011 Climate Change Strategy, the Welsh Assembly Government published an Adaptation Framework, as well as an Adaptation Delivery Plan, setting out the specific policies and programmes that aim to deliver the Framework. The Welsh Assembly Government aims to address climate vulnerability by building the evidence base on climate risks, building capacity, and raising awareness within organisations and communities.

The Environment Bill (Wales) is currently being debated by the Welsh Assembly and is expected to be passed in July 2016. It will introduce measures on flood and coastal erosion risk management, as well as a duty on Welsh Ministers to set targets for reducing greenhouse gas emissions.

The Adaptation Sub-Committee does not have a scrutiny role on the implementation of the Framework and the Delivery Plan, unless requested to do so. Following such a request, the ASC reported on progress in Wales in 2011 and 2013.

Northern Ireland

Under the provisions of the UK Climate Change Act, Northern Ireland Departments laid the Northern Ireland Climate Change Adaptation Programme (NICCAP) before the Northern Ireland Assembly in 2014. The NICCAP identifies a number of actions to address the risks and opportunities of climate change in Northern Ireland. It provides ongoing and planned government action in four primary areas: flooding, water, natural environment, and agriculture and forestry.

The Adaptation Sub-Committee does not have a scrutiny role on the implementation of the Programme, unless requested to do so by the Northern Ireland Assembly.

Source: Scottish Government (2014) *Scottish Climate Change Adaptation Programme*, Welsh Government (2011) *Adaptation Delivery Plan*, Northern Ireland Department of Environment (2014) *Northern Ireland Climate Change Adaptation Programme*.

A recent study of 99 countries found that 48 have some form of institutionalised adaptation process in place at the national or sectorial level.³ These are mostly in developed countries. In Europe, the majority of countries now have some form of national adaptation programme or strategy in place, or are in the process of developing one (Box 1.2).

³ Nachmany et al (2015) *The 2015 Global Climate Legislation Study*, www.lse.ac.uk/GranthamInstitute/publication/2015-global-climate-legislation-study/

Box 1.2: National adaptation programmes in Europe

The European Environment Agency (EEA) reviewed the status of national adaptation planning across Europe in 2014. Of the 30 countries that responded to EEA's questionnaire:

- 12 have published a national adaptation programme: Austria, Denmark, Finland, France, Germany, Malta, Netherlands, Norway, Spain, Switzerland, Turkey and the UK.
- 10 have an adaptation strategy, which will inform an adaptation programme.
- 8 do not yet have a strategy, but all of these except Greece are in the process of formulating one.

The EEA also reviewed whether countries are taking steps to monitor and evaluate their adaptation plans or strategies. Here they found that:

- 7 are implementing some form of monitoring and evaluation scheme: Finland, France, Germany, Lithuania, Spain, Switzerland and the UK.
- 6 are currently developing monitoring and evaluation schemes and 12 are planning to do so in the future.

Source: European Environment Agency (2014) *National adaptation policy processes in European countries — 2014*, <http://www.eea.europa.eu/publications/national-adaptation-policy-processes>

1.2 The first National Adaptation Programme

The Climate Change Act sets clear requirements for producing a National Adaptation Programme.

Under the Act, the Secretary of State has a duty to lay programmes before Parliament setting out (a) the objectives of the Government in relation to adaptation, (b) the Government's proposals and policies for meeting those objectives, and (c) the time-scales for introducing those proposals and policies.

The Act also specifies that these objectives, policies and proposals must address the risks identified in the most recent Climate Change Risk Assessment, as well as contributing to sustainable development.

Defra's approach to preparing the first NAP was based on a process of 'co-creation' between central Government and a multitude of other actors involved in adaptation at the national and more local levels.

Defra is the lead government department responsible for co-ordinating the preparation of the NAP. For the first NAP Defra took an open and consultative approach, termed 'co-creation', whereby stakeholders were encouraged to help write the NAP's objectives and propose activities for inclusion in the programme.

Many adaptation actions will require local action by businesses, households, utility companies, local authorities and a range of other public institutions. Involving a wide range of national and local stakeholders in its preparation ensured that the NAP provides a comprehensive overview of activity taking place. There are six main themes in the NAP, each with a dedicated chapter. There is also a chapter on local government, reflecting the important role that local authorities play in climate change adaptation around the country. Figure 1.2 provides a summary of the National Adaptation Programme in the form of a word cloud. Those terms most frequently used in the first NAP appear in the largest text.

Figure 1.2: Word cloud summarising the first National Adaptation Programme



Source: HM Government (2013) *National Adaptation Programme, making the country resilient to a changing climate*.
Notes: Based on the 100 most frequently used terms in the NAP, excluding common words.

Notes: Based on the 100 most frequently used terms in the NAP, excluding common words.

The NAP contains 31 objectives to address the risks identified by the CCRA. The report also provides a comprehensive snapshot of relevant policies and activity on adaptation.

Table 1.1 summarises the most urgent climate change risks and their impacts for each of the NAP themes. The impacts of flooding, water scarcity, and high temperatures, feature the most strongly across the NAP chapters.

Table 1.1: Priority climate change risks and their impacts

Climate change risks	NAP theme					
	Built Environment	Infrastructure	Healthy & Resilient Communities	Agriculture & Forestry	Natural Environment	Business
Flooding and sea level rise	Damage to residential and other buildings	Damage to exposed assets, lost services	Loss of life, mental health and well-being impacts	Impact on yields	Impacts on habitats	Damage to buildings and assets, lost business
Water scarcity	Drinking water supply shortages	Lack of water for power generation	Drinking water supply shortages	Water shortages for irrigation and livestock	Impacts on freshwater habitats	Drinking water supply shortages
Higher average and extreme temperatures	Heat-related health impacts	Infrastructure performance, e.g. cooling water	Heat-related health impacts	Impacts on livestock health	Impacts on species	Employee productivity
Pests, pathogens & invasive species			Health and well-being impacts	Impact on yields	Impacts on species	
Wildfire			Loss of life, community displacement	Impact on forestry	Impacts on habitats	
Soil aridity, erosion				Impact on yields	Impacts on habitats	
Changes in climate space, phenology				Changes in crop/timber species	Impacts on habitats and species	
Disruption to supply chains		Service disruption, e.g. fuel supplies		Impacts on yields		Lost business, reputational impacts

Source: ASC qualitative summary of the climate change risks presented in the 2012 UK CCRA, in relation to each of the themed NAP chapters.

Notes: Red boxes indicate the most urgent and important risks and impacts for each theme. Yellow boxes indicate important, but less urgent, risks and impacts.

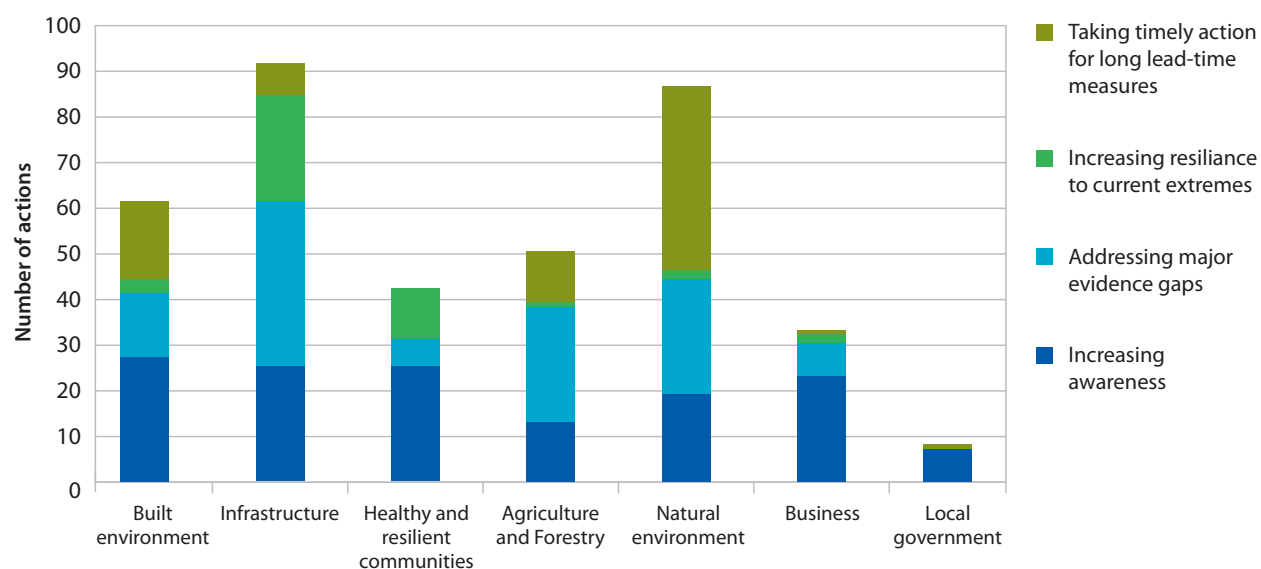
Defra interpreted the requirement of the Act to set out ‘policies and proposals for meeting the objectives’ by listing more than 370 specific actions. The majority of these actions are owned by central Government departments and their agencies. The remaining actions are owned by local government, trade bodies, universities, utility companies, regulators, voluntary groups and environmental charities. This reflects the co-creation process.

There are two broad categories of NAP action:

1. those that aim to increase awareness and address major evidence gaps; and
2. those that will increase resilience to current weather extremes and take timely action in areas involving long-lead times.

Figure 1.3 highlights, that across the chapters, most of the actions focus on raising awareness (37%) and addressing major evidence gaps (30%). These actions are owned by delivery bodies, such as the Environment Agency's Climate Ready service, as well as other organisations who have been working on adaptation for a number of years, such as Climate UK. A number of academic institutions also own actions that relate to on-going or recently completed research programmes.

Figure 1.3: Number of NAP actions by theme and type

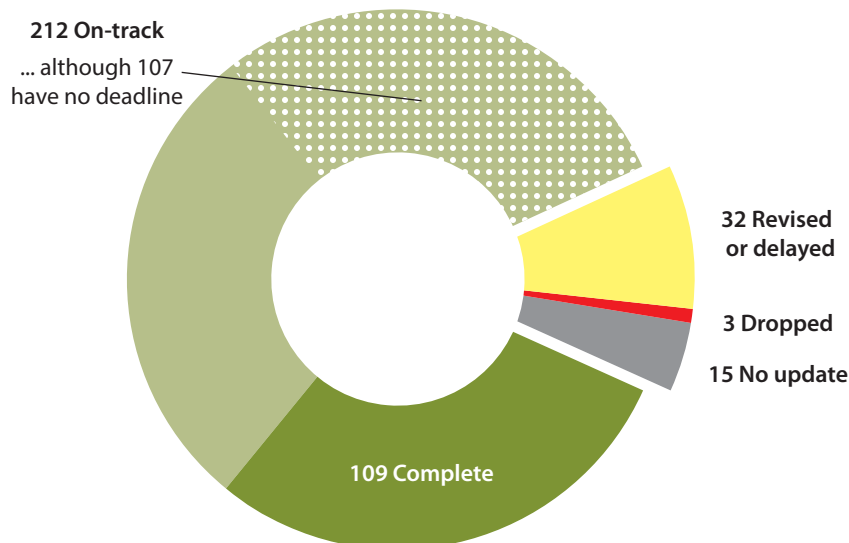


Source: ASC analysis of the actions listed in the NAP.

Good progress has been made delivering the NAP actions, with the majority either completed or on-track.

Involving stakeholders in creating the NAP has clearly helped to foster action. As of February 2015, the majority (87%) of actions were reported as being either complete or on-track. Very few actions have been delayed or dropped (Figure 1.4). However, a high proportion of actions listed in the NAP are not time-bound: 42% of the 371 actions do not have a specific delivery date.

Figure 1.4: Progress with the delivery of NAP actions



Source: ASC analysis of returns provided by NAP action owners, February 2015.

1.3 Developing the next National Adaptation Programme

The next NAP could be improved so that it is more in line with the guiding principles for policymaking set out in HM Treasury's Green Book.⁴

The Green Book requires there to be a clear rationale for why policy intervention is needed and what outcomes the policy aims to achieve. Options for delivering those outcomes should be systematically appraised and a clear process for monitoring and evaluating the programme should be established at the outset.

For the next NAP to be a successful policy programme in line with the Green Book principles, it should be driving forward cost-effective action to increase the UK's resilience to climate risks in the short-term, and ensuring that long-term decisions are accounting for the possible pace and extent of future climate change.

In the ASC's view, the first NAP falls short of the guiding principles for policymaking in three key respects:

- **The NAP gives little sense of strategic purpose:** it does not make clear which risks are the most important to address, which objectives are the most pressing, or what activity will have the biggest impact. This makes it difficult for organisations and communities to focus on the most urgent issues.
- **The NAP lists a range of useful activity but does not amount to a coherent programme:** the NAP is primarily a summary of existing policies relevant to adaptation and a snap-shot of activity already underway. To the ASC's knowledge there was no appraisal of the effectiveness of current policies to address the risks faced from climate change, nor any analysis of whether new policies and approaches might be required.
- **Progress is hard to measure:** the objectives in the NAP do not set clear outcomes against which progress can be measured. This has made it difficult to carry out a robust evaluation of the effectiveness of the programme. The Government's Domestic Adaptation Board, that oversees the NAP's implementation, does not routinely ask for updates on progress, nor has the ability to reallocate resources between priorities.

1.3.1 Introducing a clear sense of purpose

The NAP does not identify the most important climate risks that require the most urgent attention. This may in part be because the first CCRA itself did not provide a prioritised list of the most urgent climate change risks. The Evidence Report for next CCRA aims to address this. In the meantime it would still be possible for the Government to identify and state its priorities for adaptation.

The first CCRA in 2012 produced a list of over 100 individual risks and opportunities facing the UK from climate change. Each of these risks was assessed according to the magnitude of their consequences, for example the number of households potentially at risk from flooding. Each risk was also given a confidence rating. However, the first CCRA did not identify those areas where additional adaptation and policy intervention is most urgent.

⁴ HM Treasury (2013) *The Green Book: appraisal and evaluation in central government*, <https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-government>

The NAP similarly does not make clear which of these 100 or so risks require urgent policy attention. Urgency could be related to those areas where there is high confidence in the magnitude of potential impacts. It could also be based on the risk of 'lock in', where decisions taken now have long-term consequences and be difficult or costly to reverse. The potential for 'autonomous adaptation' is also a consideration, to allow the Government to focus on issues that are unlikely to resolve themselves through market forces and existing incentives.

1.3.2 Building an effective programme of activity

The NAP is a reflection of the activity that was underway at the time of its publication. The process of co-creation should continue and be expanded, but the next NAP should make clear where the biggest gains in managing vulnerability are to be made, and what activities will have the greatest impact.

In the year prior to the publication of the NAP, the Government undertook an appraisal of the costs and benefits of different adaptation policy options.⁵ However, it is not clear how this appraisal informed the NAP. To the ASC's knowledge the appraisal did not assess the extent to which current policies are cost-effectively addressing the risks identified by the CCRA. There was also little apparent analysis of whether new or stronger policies might be required.

The level of stakeholder engagement undertaken for the first NAP was undoubtedly a success and should continue. The next NAP should aim to go further, reaching out to businesses and communities so that the full breadth of adaptation activity is reflected.

However, the next NAP should then draw together a coherent programme from the individual elements. The Government should assess whether additional effort is needed in priority areas, beyond existing plans and policies, in order to make progress towards the stated objectives. The next NAP should ensure that policies and activities are commensurate with the scale of the adaptation challenge in each priority area.

1.3.3 Monitoring and reviewing progress

The current NAP objectives are phrased in ways that make them hard to measure. As a result it is difficult to say whether they are being met. To be able to properly assess progress, NAP objectives should be more specific, with clear outcomes and timescales that can be measured and monitored.

The majority of the objectives in the NAP focus on raising awareness, building capacity, and addressing evidence gaps. Few objectives state an actual policy goal in terms of, for example, achieving specified and acceptable levels of risk, or improving resilience to a particular cost-effective standard. The current objectives tend to have multiple facets, conflate processes and outputs, and in some cases span a number of climate change risks.

Having multiple aspects to them, and the lack of specific outcomes, makes it difficult to assess whether objectives are being achieved. This in turn means it is difficult to demonstrate the effectiveness of the NAP in addressing the CCRA risks.

⁵ Frontier Economics, Irbaris and Ecofys (2013) for HM Government, *The Economics of Climate Resilience*, <http://randd.defra.gov.uk/Default.aspx?Module=More&Location=None&ProjectID=18016>

Similarly, many of the actions in the NAP are also written in ways that makes it difficult to assess whether they are complete. As noted above, almost half of all actions (42%) have unclear timescales, and as a result can be classed as 'on-going' by those responsible for delivery. Some actions do not specify clear ownership, for example applying to 'all communities'. There are only a few examples of action owners providing evidence of how their work has helped to reduce specific vulnerabilities.

A cross-Whitehall Domestic Adaptation Board was established by Defra after the Climate Change Act gained assent. It is responsible for overseeing the NAP's implementation. However, this Board does not routinely ask for updates on progress, nor has the ability to reallocate resources between priorities. As a result, no regular monitoring or accountability arrangements have been put in place to assess the progress being made by the owners of the NAP actions.

Instead, a relatively ad-hoc process was agreed over a year after the NAP's publication. This aimed to provide the ASC with updates to inform this statutory assessment of the NAP. These updates were provided by the Government in February 2015.

Based on this assessment, the ASC recommends that the Government improves the approach to the next NAP due in 2018.

RECOMMENDATION 1: The second National Adaptation Programme should:

- **Set clear priorities for adaptation:** to make sure the most important and urgent issues are being addressed. As well as this report, the next Climate Change Risk Assessment will help the Government identify the most urgent risks facing the UK from climate change, to provide a clearer focus for the next NAP.
- **Ensure objectives are specific, outcome-focused, and measurable:** objectives should focus on priority outcomes, and what needs to be achieved in real-world terms, rather than describing processes and activities.
- **Focus on the core set of policies and actions that will have the biggest impact:** each with specific goals, responsibilities and timing. It should be clear how each action helps address one or more of the risks identified as requiring urgent attention by the next CCRA.
- **Build on the breadth of local community and business engagement in the first NAP:** in order to ensure the second NAP reflects regional differences in climate change impacts and that local organisations and interests continue to play a role in delivery.
- **Introduce effective monitoring and evaluation:** that allows progress to be measured on a regular basis so that policies can be strengthened and resources reallocated (including between departments) if need be, in order to ensure the objectives are being achieved.

1.3.4 Towards a National Adaptation Pathway

Where appropriate, the next NAP could also adopt a 'pathways' approach to managing the risks from climate change. Considering alternative pathways towards long-term goals is a useful technique when the scale of impact is uncertain and the lead-times for decision making are long. Taking a pathways approach requires the sequence of decisions that may be needed to achieve long-term goals to be understood. It also highlights what changes in the observed or projected climate may provoke a different course of action to be taken. Both are useful in the face of uncertainty.

Adaptation pathways focus on the long-term and uncertain nature of climate change. They enable the adjustment of adaptation strategies in response to new information and changing circumstances, in ways that are as efficient and transparent as possible. The approach builds flexibility into an adaptation strategy through the development of a range of options to deal with different climate scenarios. The approach has been applied to date at a relatively small spatial scale for risks that have a strong quantitative evidence base.

Whilst not appropriate for every NAP objective, there are a number of elements of the pathways approach that should inform the preparation of the next NAP:

- **Acceptable levels of risk.** Pathways consist of adaptation strategies and interim targets that are related to long-term adaptation goals. These goals are based on defined acceptable levels of risk, such as the number of properties that are at a high likelihood of flooding by a certain date. The next NAP could set objectives in terms of acceptable levels of risk, to provide clarity, and enable effective evaluation of progress towards the Government's targets.
- **Trigger points and limits.** Decisions on different adaptation strategies are triggered when acceptable levels of risk are exceeded. These trigger points build in lead times that take account of the time it takes to act and for the benefits to be realised. This could include the need to undertake further research, which in turn informs future adaptation strategies. The next NAP could identify explicit trigger points in relation to each priority risk.
- **Range of options.** Taking a pathways approach involves identifying different options that perform reasonably well across a range of climate futures, rather than perhaps being ideal in only one climate scenario. For the NAP, this would mean that each policy would need to consider alternative options to the status quo, and under what conditions these options may need to be adopted.
- **Monitoring and evaluation.** To inform decisions, it is essential to track climate variables and impacts. This requires the development of key indicators. The next NAP should include a set of key indicators for each objective, building on the indicator set the ASC has collated.

1.4 Evaluating progress by the National Adaptation Programme

The Committee on Climate Change, advised by its Adaptation Sub-Committee, has a duty under the Climate Change Act to report to Parliament with its assessment of progress with the implementation of the objectives, policies and proposals in the NAP. The ASC has structured this assessment according to a set of specific and measurable ‘adaptation priorities’.

Ideally, we would assess the progress being made towards achieving the NAP’s objectives. However, as noted above, the objectives tend to describe processes rather than outcomes and do not always state meaningful goals against which progress can be measured. Even where stated objectives are being achieved, vulnerability to climate change impacts may be increasing.

To enable a robust assessment, we have divided each of the NAP themes into specific and measurable factors that are the most important for managing the risks from climate change. We have called these factors ‘adaptation priorities’.

For example, to assess the progress being made with managing the risks from climate change to the built environment it is important to understand what is happening with community-scale flood alleviation, surface water flood management, residual flood risk to existing properties, and new development in flood risk areas. As well as flooding, it is important to also understand whether progress is being made in adapting the built environment to the risks from heat stress, and water scarcity. These six areas form the adaptation priorities for the built environment theme.

Adaptation priorities have been identified for each of the six NAP themes, based on the research and analysis completed by the ASC over the past five years. As well as the actions listed in the NAP, we have also reviewed implementation of any other relevant policies or commitments that were not mentioned or may have been introduced since. The aim is to provide a complete and comprehensive evaluation of the progress being made.

For each adaptation priority, the ASC has considered:

- **Is there a plan?** Here we assess whether there is an explicit policy or plan in place that aims to address the relevant climate risks. For example, the National Planning Policy Framework explicitly considers climate change and provides a basis for appropriate planning decisions that take account of current and future flood risk.
- **Are actions taking place?** This considers whether the specific actions listed in the NAP have been delivered, or are on track. The actions in the NAP are effectively the ‘policies and proposals’ described in the Act. In order to be comprehensive, the assessment is not restricted to only those actions listed in the NAP. Any significant action taking place outside of the NAP also forms part of the assessment.
- **Is progress being made in managing vulnerability?** This forms the ASC’s overall evaluation of progress. The assessment takes account of the scale of the current and future risks, and the impact of relevant policies and actions. Where possible, the evaluation is based on the suite of indicators that the ASC has developed, that measure over time changes in exposure and vulnerability, and observed impacts, within each priority area. Where appropriate, account is taken if actions will take time to deliver measurable changes in vulnerability. The assessment builds on research and analysis undertaken by the ASC and presented in our past non-statutory progress reports. These reports can be found on the CCC’s website.

Our evaluation takes account of the updates we have received from the owners of the NAP actions. In particular, we have looked for evidence of low regret activity and sensible long-term decision making.

- We have analysed whether low-regret adaptation measures are being taken, such as for example water metering in areas already at risk from water stress. If we observe appropriate uptake of low-regret measures, then it is likely that progress is being made with addressing the adaptation priority.
- We have also reviewed the extent to which long-term decision-making is accounting for climate change projections. For example, we consider whether the planning system is delivering new infrastructure that will remain resilient or can be adapted as the climate changes. If we find that decisions are taking future climate change risks into account, then it is likely that the adaptation priority is being addressed.

We received updates on 356 of the 371 actions listed in the NAP, a return rate of 96%. The full text of the updates received is available within an annex to this report on the CCC's website.⁶

For each adaptation priority we have given a Red-Amber-Green (RAG) score to summarise our evaluation of progress. Annex 1.1 explains the criteria used in arriving at these scores. We have also made specific recommendations where our evaluation suggests that additional policy intervention or other activity may be required.

The combinations of RAG scores for each adaptation priority highlight the likely implications for policy. Examples of some of the possible combinations of RAG scores, and their implications, are set out in Annex 1.2.

In each chapter we make recommendations where, in our 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 seven themes in the NAP.

Each chapter follows a consistent structure, providing:













- an overview of the theme, and the Government's vision and objectives as set out in the NAP;
- a description of the primary climate risks 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 NAP objectives; and
- recommendations for where new or revised policies should be considered, or where implementation of existing policy requires strengthening.

⁶ See: <http://www.theccc.org.uk/publications/>

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

Adaptation priority	Is there a plan?	Are actions taking place?	Is progress being made in managing vulnerability?
<p>For example:</p> <ul style="list-style-type: none"> Community-scale flood alleviation Heat-related health impacts Resilience of infrastructure services to extreme weather Water demand by industry 	<p>Green – where needed, plans or policies are in place to fully address the adaptation priority in the context of climate change.</p> <p>Amber – plans or policies in place that partially address the adaptation priority.</p> <p>Red – no specific policies or plans are in place.</p>	<p>Green – all relevant NAP actions are complete or on-track, other relevant plans and policies are being implemented.</p> <p>Amber – not all relevant NAP actions are on-track, with partial delivery of other relevant plans and policies.</p> <p>Red – policies are not being implemented and relevant actions are behind schedule.</p> <p>Grey – no specific actions in the NAP, no apparent activity underway.</p>	<p>Green</p> <ul style="list-style-type: none"> Vulnerability reducing, or not increasing. High uptake of low-regret actions. Long-term decisions are accounting for climate change projections. <p>Amber</p> <ul style="list-style-type: none"> Some trends in vulnerability increasing. Scope to increase low-regret action. Decisions partially or inconsistently accounting for climate change projections. <p>Red</p> <ul style="list-style-type: none"> Most trends in vulnerability increasing. Minimal uptake of low-regret actions. Decisions do not take climate change projections in to account. <p>Grey</p> <ul style="list-style-type: none"> Insufficient evidence to make a judgement.

Annex 1.2: Examples of Red-Amber-Green combinations

Is there a plan?	Are actions taking place?	Is progress being made in managing vulnerability?	What does it mean? Implications for the Government
 Red	 Red	 Red	<ul style="list-style-type: none"> • There is no plan or policy to address the risk, actions are not being completed, and trends in vulnerability are increasing. • Develop stronger policies, and closer monitoring of implementation required.
 Red	 Green	 Red	<ul style="list-style-type: none"> • Actions are being taken, but policies and plans are insufficient to counter increasing vulnerability. • Develop more ambitious policies and plans that initiate a stronger range of activity.
 Green	 Green	 Green	<ul style="list-style-type: none"> • There is a plan, it is being implemented, and measures of vulnerability are improving. • Continue to implement current policy.
 Green	 Green	 Amber	<ul style="list-style-type: none"> • Comprehensive policies and plans are in place, activity is on track, but there is mixed evidence of progress or it is too early to tell. • Continue to implement current policy, monitor and review in case more effort required.



Chapter 2: Built environment

- 2.1 Climate change and the built environment
- 2.2 Risks to the built environment from climate change
- 2.3 Progress being made
- 2.4 Conclusions on NAP objectives and actions



Key messages

The impacts of climate change on people and the economy will to a significant degree be determined by how well the built environment is adapted to the future climate. Many towns and cities in England are located in the floodplain and so are at risk from river and coastal flooding. The make-up of built-up areas, including the amount of urban greenspace, influences the risk of both surface water flooding and heat stress. The design of individual buildings also determines how people will be impacted by heatwaves (see Chapter 4: Healthy and Resilient Communities) and how much water they use.

Although progress is being made with long-term planning for flood risks, and improving water efficiency, many aspects of England's built environment are ill-prepared for a changing climate. Existing policy is inadequate to address the hundreds of thousands of properties projected to face high levels of flood risk in the future, with new development adding to this number. Progress in managing surface water flooding has been slow. As yet there are no firm proposals that will adapt the built environment to minimise the health impacts from increasing summer temperatures.

Overview of progress

Adaptation priority	Is there a plan?	Are actions taking place?	Is progress being made in managing vulnerability?
1. Community-scale flood alleviation	Green	Green	Amber
2. Surface water flood management	Green	Amber	Red
3. Avoid inappropriate development in flood risk areas	Green	Green	Amber
4. Residual flood risk to existing properties	Red	Green	Red
5. Heat-related health impacts (covered in Chapter 4: Healthy and Resilient Communities)	Amber	Green	Red
6. Water demand in the built environment	Green	Amber	Green

Note: The criteria for Red, Amber, Green or Grey status for each of the three questions are as follows:

Is there a Plan? Green – where needed, plans or policies are in place that fully address the adaptation priority in the context of climate change.

Amber – plans or policies are in place that partially address the adaptation priority. Red – no specific policies or plans are in place.

Are actions taking place? Green – all relevant NAP actions are complete or on-track, other relevant actions or commitments are being implemented. Amber – not all relevant NAP actions are on-track, partial delivery of other actions or commitments. Red – NAP actions mostly delayed or dropped, other relevant actions behind schedule.

Is progress being made in managing vulnerability? Green – trends in vulnerability are reducing or not increasing; there is high uptake of low-regret adaptation measures; long-term decisions are accounting for the future climate. Amber – some trends in vulnerability are increasing; scope to increase low-regret adaptation, decisions partially or inconsistently account for the future climate. Red – most trends in vulnerability increasing; minimal or zero uptake of low-regret adaptation; long-term decisions not taking the future climate into account. Grey – insufficient evidence to make a judgement.

See Chapter 1 for a full description of the approach.

Summary of progress

Progress is being made with a number of policies referred to in the National Adaptation Programme (NAP):¹

- **Flood risks are being managed, with long-term planning and investment in place.** The Environment Agency has published updated Long-Term Investment Scenarios for flood and coastal erosion risk management to the 2060s. Investment in new and improved flood and coastal defences since April 2011 has helped better protect around 180,000 homes, exceeding the original target of 145,000. A six-year programme of capital investment to 2021 has been agreed with HM Treasury.
- **National planning policy is ensuring that floodplain development is primarily located in areas well-protected by existing flood defences.** Nearly three-quarters of development on the floodplain since 2001 has been in areas with a low likelihood of flooding (between a 1-in-100 and 1-in-1,000 annual chance). The Environment Agency comments on all residential planning applications in areas with a 1-in-100 or greater annual chance of river flooding, or a 1-in-200 or greater annual chance of coastal flooding, regardless of the size of the development. The Agency's advice is almost always followed by local planning authorities.
- **Water demand measures are being rolled-out.** The latest water company business plans increase the emphasis on water efficiency and reducing leakage. Installation of water meters is progressing and overall water consumption per person is declining, albeit at a relatively slow pace and against a backdrop of population growth in many water-stressed areas. New developments have high standards of water efficiency, particularly in areas at risk of being water stressed now and in the future.

However, there are a number of trends that suggest the vulnerability of the built environment to climate change impacts is increasing.

- **Surface water flood risk is not being adequately addressed.** The automatic right for new development to be connected to public sewers remains, regardless of their capacity. Front gardens continue to be paved over and sales of permeable paving remain very low. Key recommendations of the Pitt Review² regarding local flood risk management and the uptake of sustainable drainage systems (SuDS) have still not been implemented. In April, the last Government introduced changes to the planning system to encourage SuDS in new development. However, the changes fail to address the fundamental barriers to the uptake of SuDS highlighted by the Pitt Review. There are no plans to monitor or review the effectiveness of the new approach.
- **Increasing numbers of existing properties will be at high flood risk in the future.** Even if all cost-effective community flood defences are built, and there is no new development in the floodplain, there are expected to be more properties in areas at a 1-in-30 or greater annual chance of flooding in the 2060s than there are now. The pace of fitting low-regret property-level flood protection (PLP) measures for these high-risk properties is very slow. Flood Re, the new subsidised flood insurance scheme, largely removes the financial incentive to fit PLP measures. As currently configured, Flood Re is counter-productive to the long-term management of flood risk and represents poor value for money.

¹ HM Government (2013) *National Adaptation Programme, making the country resilient to a changing climate*, www.gov.uk/government/publications/adapting-to-climate-change-national-adaptation-programme

² Sir Michael Pitt (2008) *Learning lessons from the 2007 floods*, http://webarchive.nationalarchives.gov.uk/20100807034701/http://archive.cabinetoffice.gov.uk/pittreview/thepittreview/final_report.html

- **Development in high-risk parts of the floodplain is continuing to build up risk.** Whilst the majority of floodplain development since 2001 has been in lower risk areas, around ten percent (averaging 1,500 new homes per year) has been in areas at a 1-in-30 annual chance of flooding or greater. Such areas are categorised as at high flood risk, with any flood defences in place inadequate to move these properties to a lower flood risk category. New development is increasing the consequences of flood events and locking future generations in to increasing flood defence costs.
- **Vulnerability to heat stress is increasing.** Existing buildings already overheat in relatively cool summers and new homes are being built without due regard to increasing temperatures. There is very low uptake of passive cooling measures in both new and existing properties. A high proportion of new homes are flats, the most vulnerable type of property to excessive internal temperatures. The amount of urban greenspace, which can help to cool built-up areas, is declining. There are as yet no substantive proposals to manage the increasing health and well-being impacts of heat stress in the built environment. This issue is covered in more detail in Chapter 4: Healthy & Resilient Communities.

Recommendations for further progress

- **RECOMMENDATION 2:** Defra should take steps to address the increasing number of homes and other properties expected to be at high flood risk in the coming decades, publishing a strategy within a year of this report. Full use should be made of the opportunities presented by the Flood Re subsidised insurance scheme to encourage households in high flood risk areas to take steps to reduce the potential for flood damage.
- **RECOMMENDATION 3:** Defra should (a) amend in this Parliament the 1991 Water Industries Act in order to remove or make conditional the current automatic right to connect new development to public sewers and (b) work with local government representatives to improve local flood risk management arrangements. Both elements should be part of an action plan to tackle surface water flood risk, to be published by Defra within a year of this report.
- **RECOMMENDATION 4:** DCLG should by the time of the ASC's next report in 2017 (a) make water companies statutory consultees on all planning applications that have implications for the public sewer network; (b) put in place a process for monitoring and evaluating the effectiveness of planning policy in (i) achieving a high uptake of SuDS in new development and (ii) limiting the paving-over of front gardens with impermeable surfaces.
- **RECOMMENDATION 5:** Ofwat should require each water company to report on the area of land where above-ground SuDS, including permeable paving, has been installed over the current Asset Management Plan (AMP) period to 2020, as part of delivering the industry-wide commitment to reduce sewer flooding incidents by 33%.
- **RECOMMENDATION 6:** DCLG and the Environment Agency should by the time of the ASC's next report in 2017 publish an assessment quantifying the impact of new development on long-term flood risk. The evidence from this assessment should be used to inform subsequent Environment Agency long-term investment scenarios.
- **RECOMMENDATION 7:** Flood Re's transition plan, required within three months of Flood Re Ltd. being formally designated the scheme administrator, should include clear proposals for how the scheme will promote flood risk alleviation amongst high risk households.
- **RECOMMENDATION 8:** Ofwat should continue to work with the Environment Agency and water companies to ensure that action is being taken to manage household demand for water. This will require ambitious demand reduction commitments in the next round of long-term water resources management plans, due in 2019, including ensuring sustained increases in metering and a continued reduction in average per person consumption.

Vision: “Buildings and places and the people who live and work in them are resilient to a changing climate and extreme weather and organisations in the built environment sector have an increased capacity to address the risks and take the opportunities from climate change.”

HM Government, 2013 National Adaptation Programme

2.1 Climate change and the built environment

The built environment consists of man-made structures, primarily buildings, together with their surroundings, as well as local infrastructure such as sewers, highways, parks and open spaces.

The built environment is a priority for adaptation because buildings and their occupants are sensitive to extreme weather, particularly flooding, and because decisions on the design of the built environment generally have long-term consequences. The impacts of climate change on people and the economy will to a significant degree be determined by whether the built environment is well-adapted to the future climate. Buildings have long operational lifetimes and slow replacement rates. What has been built, and is being built, will significantly influence future impacts:

- New homes have design lives of 60 years, but most of these will exist well in to the 22nd century.
- Around 85% of today's homes are more than 20 years old.
- The replacement of building stock is low, typically 1% per year. Therefore, around 80% of the buildings that will be in use in the 2050s have already been built.

2.2 Risks to the built environment from climate change

Buildings and their occupants are vulnerable to a number of climate-related risks including flooding, extreme heat, potential water shortages during major droughts, and other risks, such as subsidence.

- Many towns and cities in England are located on the river and coastal floodplain. Most of the highest order risks for the built environment in the first Climate Change Risk Assessment (CCRA) were associated with the impacts of flooding.³
- Average and extreme summer temperatures are projected to rise, posing risks to health and well-being. The Urban Heat Island (UHI) effect, where built-up areas are significantly warmer than their surroundings, is already observed and is projected to intensify in a warming climate.
- Increasing pressure on water resources is also expected, within, but not limited to, areas that are already water stressed. Buildings will need to become increasingly water efficient as changes in water availability may lead to a less reliable supply.

These risks are projected to increase with climate change. Social and economic factors will affect the vulnerability of people and the built environment to those climate risks both positively and negatively. This vulnerability can be managed to some extent through adaptation.

In keeping with other themes, adaptation priorities within the built environment focus on two broad areas:

³ HM Government (2012) *UK Climate Change Risk Assessment: Government Report*, www.gov.uk/government/publications/uk-climate-change-risk-assessment-government-report

- **Low regret actions:** steps that deliver immediate or short-term benefits and where projections of climate change only make the case for action stronger. Investing in community-level flood defences in areas already at risk is an example of a low regret adaptation strategy.
- **Avoiding lock-in:** preventing changes to the built environment that will lock future generations into increasing climate impacts, or that will be costly to avoid or reverse. Building new homes and properties in areas projected to be at high flood risk in the coming decades is one such example.

Making allowances for projected changes in the climate in new development, and during the renovation of existing buildings, is likely to be easier and less costly than widespread retrofitting in the future.

In response to these risks, the Government's National Adaptation Programme (NAP) sets six objectives for the built environment theme.⁴

The objectives were identified following consultation across a wide range of stakeholders with expertise in climate change and the built environment, including industry representatives, statutory bodies, and experts from academia and technical organisations.

- **Objective 1:** To work with individuals, communities and organisations to reduce the threat of flooding and coastal erosion, including that resulting from climate change, by understanding the risks of flooding and coastal erosion, working together to put in place long-term plans to manage these risks and making sure that other plans take account of them.
- **Objective 2:** To provide a clear local planning framework to enable all participants in the planning system to deliver sustainable new development, including infrastructure, that minimises vulnerability and provides resilience to the impacts of climate change.
- **Objective 3:** Help businesses and industries in the sector to access skills, training, knowledge and tools to understand and manage climate change risks.
- **Objective 4:** To ensure that investors and developers have the financial and appraisal decision tools needed to support and promote adaptation to climate change.
- **Objective 5:** To increase the resilience of homes and buildings by helping people and communities to understand what a changing climate could mean for them, and to take action to be resilient to climate risks.
- **Objective 6:** To explore and build understanding of the long term implications of climate change for the location and resilience of population centres.

The NAP objectives describe important high-level principles and processes for adaptation in the built environment. We have reviewed progress by the actions in the NAP against each objective in Section 2.4 below.

As noted in Chapter 1, the NAP objectives tend to describe processes rather than outcomes and do not always state goals against which substantive progress can be measured. Even where the 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 NAP themes. The progress being made in respect of each of these adaptation priorities is reviewed in Section 2.3.

Figure 2.1 summarises the climate hazards, contextual factors and adaptation priorities that are relevant to the built environment, together with a summary of the actions listed in the NAP. Note that whilst the adaptation priority of 'heat-related health impacts' is equally relevant to the built environment theme, it is covered in detail in Chapter 4: Healthy & Resilient Communities.

⁴ HM Government (2013) *National Adaptation Programme, making the country resilient to a changing climate*, www.gov.uk/government/publications/adapting-to-climate-change-national-adaptation-programme




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

Climate hazards	Contextual factors	Adaptation priorities	Relevant NAP actions
Flooding Water scarcity Drought Heavier rainfall Sea level rise Higher average and extreme temperatures	Population growth	Community-scale flood alleviation	<ul style="list-style-type: none"> • Implement National Flood & Coastal Erosion Risk Management Strategy for England
		Surface water flood management	<ul style="list-style-type: none"> • Implement local flood risk management strategies • Increase use of sustainable drainage systems
	Demographic change	Avoid inappropriate development in flood risk areas	<ul style="list-style-type: none"> • Implement National Planning Policy Framework
	Economic growth	Residual flood risk to existing properties	<ul style="list-style-type: none"> • Promote property-level flood protection
	Average property occupancy	Heat-related health impacts	<ul style="list-style-type: none"> • Review housing policies and regulations in relation to heat • Implement Green Infrastructure Partnership work on adaptation
		Water demand in the built environment	<ul style="list-style-type: none"> • Implement Water Resources Management Plans • Implement Building Regulations

2.3 Progress being made

This section evaluates the extent to which the actions and policies in the NAP and elsewhere are addressing the identified climate risks, following the method described in Chapter 1. Further details and the underlying evidence supporting the analysis is provided in an annex to this report available on the CCC's website.⁵

2.3.1. Community-scale flood alleviation

Is there a plan?		The National Flood and Coastal Erosion Risk Management Strategy for England sets the policy framework for managing vulnerability to flood risk now and in the future. In December 2014, the Environment Agency published a new set of long-term investment scenarios to consider the optimal investment path to the 2060s. At the same time, Defra published a six-year investment plan of flood and coastal defence schemes to be taken forward over the period to 2021.
Are actions taking place?		The Government delivered better protection against flooding and coastal erosion to around 180,000 households between April 2011 and March 2015, exceeding the original 145,000 target for the period.
Is progress being made in managing vulnerability?		There has been underinvestment in flood risk management since 2011. As a consequence expected flood damages are likely to be higher now than they were in 2010. Even in the best case scenario of no new development on the floodplain, optimal investment over several decades, and every cost-effective flood and coastal defence being built, there are still expected to be more homes in areas of high flood risk in the coming years.

⁵ See: www.theccc.org.uk/publications/

The NAP highlights that investment in flood defences will continue through delivery of the National Flood and Coastal Erosion Risk Management Strategy for England.⁶ The strategy includes action to better understand flood risk, invest in reducing the chance of flooding, and improving flood prediction, warning and emergency response arrangements. Significant advances have been made in each of these areas. However, overall, there has been underinvestment in managing flood risk over the past four years.

- New, more detailed maps of flood risk were published by the Environment Agency in December 2013. For the first time, maps showing areas of surface water flood risk were made available to the general public. Since then, the data underlying these maps have been made openly available as a free download through the public sector dataset portal.
- The major east coast tidal surge of December 2013 was forecast six days in advance. Further refinements to tidal surge forecasting have been made since.⁷ The reliable, early forecast allowed time for emergency response plans to be initiated in advance of the surge, including the evacuation of 18,000 people from low lying areas. Together with the improvements in flood defence structures over many decades, early warnings helped ensure no-one died as a direct result of the 2013 surge event. The tidal surge in 1953, of a similar magnitude, killed 307 people.
- A total of £2.55 billion was allocated by central Government to managing flood and coastal erosion risks in England over the last spending period from April 2011 to March 2015. In addition, there has been a marked growth in external contributions under the Flood and Coastal Resilience Partnership Funding policy introduced in May 2011. Under the policy, over the last four years, an estimated £140 million in external funding contributions has been leveraged by the Environment Agency and local authorities (Figure 2.2).^{8,9} Together this has resulted in schemes that have provided better protection to around 180,000 homes in England since April 2011. Most of these homes will already have been protected by flood defences. The term 'better protection' includes action to refurbish, or replace like-for-like, existing flood defences at the end of their design life.
- The Environment Agency published in December 2014 an updated set of long-term investment scenarios (LTIS2).¹⁰ The scenarios consider the optimal investment path to the middle of this century based on assumptions about the rates of asset deterioration, new development, and climate change.
- Defra has secured a long-term commitment from HM Treasury to invest in new and improved flood and coastal defence structures and other capital projects over the period from 2015 to 2021. In December 2014 Defra published a six-year investment plan to take forward over 1,400 schemes across England.¹¹ Delivery of the programme relies on significant additional contributions being secured from communities and project partners, averaging £60 million per year, and efficiencies that in effect add a further £40 million per year to the programme. Half of the schemes are reliant on contributions being secured and at least 200 projects won't enter construction until 2021 at the earliest.¹² However, if schemes proceed as planned the Environment Agency estimates that by 2021 there may be a 5% net reduction in expected annual flood damage.¹³

6 Defra, Environment Agency (2011) *Understanding the risks, empowering communities, building resilience*, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/228898/9780108510366.pdf

7 DfT (2015) *Transport Resilience Review: Update Report*, www.gov.uk/government/publications/transport-resilience-review-governments-response

8 Defra (2015) *Central Government Funding for Flood and Coastal Erosion Risk Management in England*, www.gov.uk/government/uploads/system/uploads/attachment_data/file/401305/Central_Government_Funding_for_Flood_and_Coastal_Erosion_Risk_Management_in_England_feb_2015.pdf

9 The £2.55 billion total includes a temporary funding increase of £213 million across the 2013/14 and 2014/15 financial years to repair the damage to England's flood defences caused by the storm surge in December 2013 and the winter storms of 2013/14. The total also includes funding provided to local authorities for their roles under the 2010 Flood and Water Management Act.

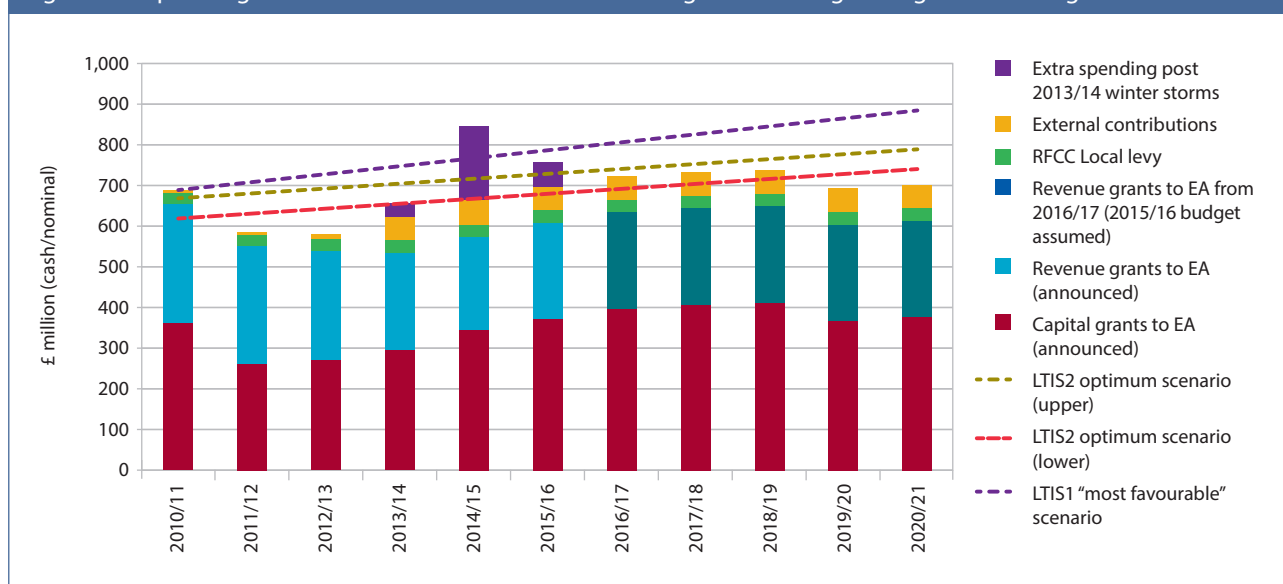
10 Environment Agency (2014) *Long-term investment scenarios 2014*, <https://www.gov.uk/government/publications/flood-and-coastal-risk-management-in-england-long-term-investment>

11 Defra (2014) *Reducing the risks of flooding and coastal erosion: an investment plan 2014*, www.gov.uk/government/publications/reducing-the-risks-of-flooding-and-coastal-erosion-an-investment-plan-2014

12 See CCC blog: <http://www.theccc.org.uk/2014/12/05/new-long-term-investment-scenarios-point-to-the-need-for-much-greater-flood-resilience/>

13 Defra (2014).

Figure 2.2: Spending on flood and coastal erosion risk management in England against the long-term need



Source: ASC based on Defra (2015), Central Government Funding for Flood and Coastal Erosion Risk Management in England, and Environment Agency (2014 and 2009), Long-Term Investment Strategy/Scenarios.

Notes: Money retained by Defra, and spending by local authorities on local flood risk management, are excluded from the figures. All figures are presented in cash/nominal terms, with inflation included at 1.5% per annum.

The 'most favourable' long-term investment scenario identified in the Environment Agency's 2009 Long-Term Investment Strategy (LTIS1) required an average of £20 million more plus inflation to be spent each and every year to 2035 in order to avoid an increase in the number of properties in areas of significant flood risk (1-in-75 annual chance of flooding or greater). The optimal investment path identified in the Environment Agency's 2014 Long-Term Investment Scenarios (LTIS2) suggested a slower rate of increase may be possible, starting at between £750 million and £800 million in 2014/15 (of between £665 million and £715 million in 2014/15 once funding for local authority flood risk management is removed).

Please see the exhibit file for full notes, available as an annex to this report on the CCC's website.

Over the last four years there has been underinvestment in flood and coastal risk management in England, totalling more than £200 million.¹⁴ Due to this underinvestment, expected annual flood damage will be higher now than it was in 2010.

There has been underinvestment in maintaining existing flood defences as well as in providing new and improved asset structures. Following the 2010 Spending Review, the Environment Agency's annual revenue maintenance budget began to decline and was due to fall to £135 million in 2014/15 (a 20% reduction on the 2010/11 budget of £169 million). Both the ASC and the National Audit Office¹⁵ have reported that even the current annual maintenance budget, reinstated to £170 million after the 2013/14 winter storms, means that at least half of flood defence systems are not being maintained in accordance with their long-term needs. The Environment Agency's revenue budget, which includes maintenance, has not been agreed beyond the current financial year ending in March 2016. A recent Environment Agency review suggested that the optimal amount of routine maintenance would cost £220 million per year, £50 million more than the current budget.¹⁶

More recent discussions with the Environment Agency (April 2015) suggest that when the rate of capital renewal and replacement of assets is factored in the optimal level of ongoing maintenance falls to between £170 million and £190 million per year. An independent review of flood and coastal defence asset maintenance was commissioned in light of the 2013/14 winter storms.¹⁷ According to the Environment Agency this suggests that there is scope for additional efficiencies in maintenance if there is longer-term certainty over revenue budgets, and if there is sufficient investment in improved asset management systems and procedures. This may allow budgets to fall by round 15% over time and still deliver current levels of maintenance activity. The spending review due in autumn 2015 will determine future maintenance budgets in light of this evidence.

¹⁴ The difference between the optimal investment path for the period suggested by LTIS2, less spending on local flood risk management and Defra's retained budget (£2.7 billion) and actual expenditure, including contributions and local levies, and efficiencies, less capital funds spent repairing defences damaged in the 2013/14 winter storms (£2.48 billion). See Figure 2.2.

¹⁵ NAO (2014) *Strategic flood risk management*, www.nao.org.uk/report/strategic-flood-risk-management-2/#

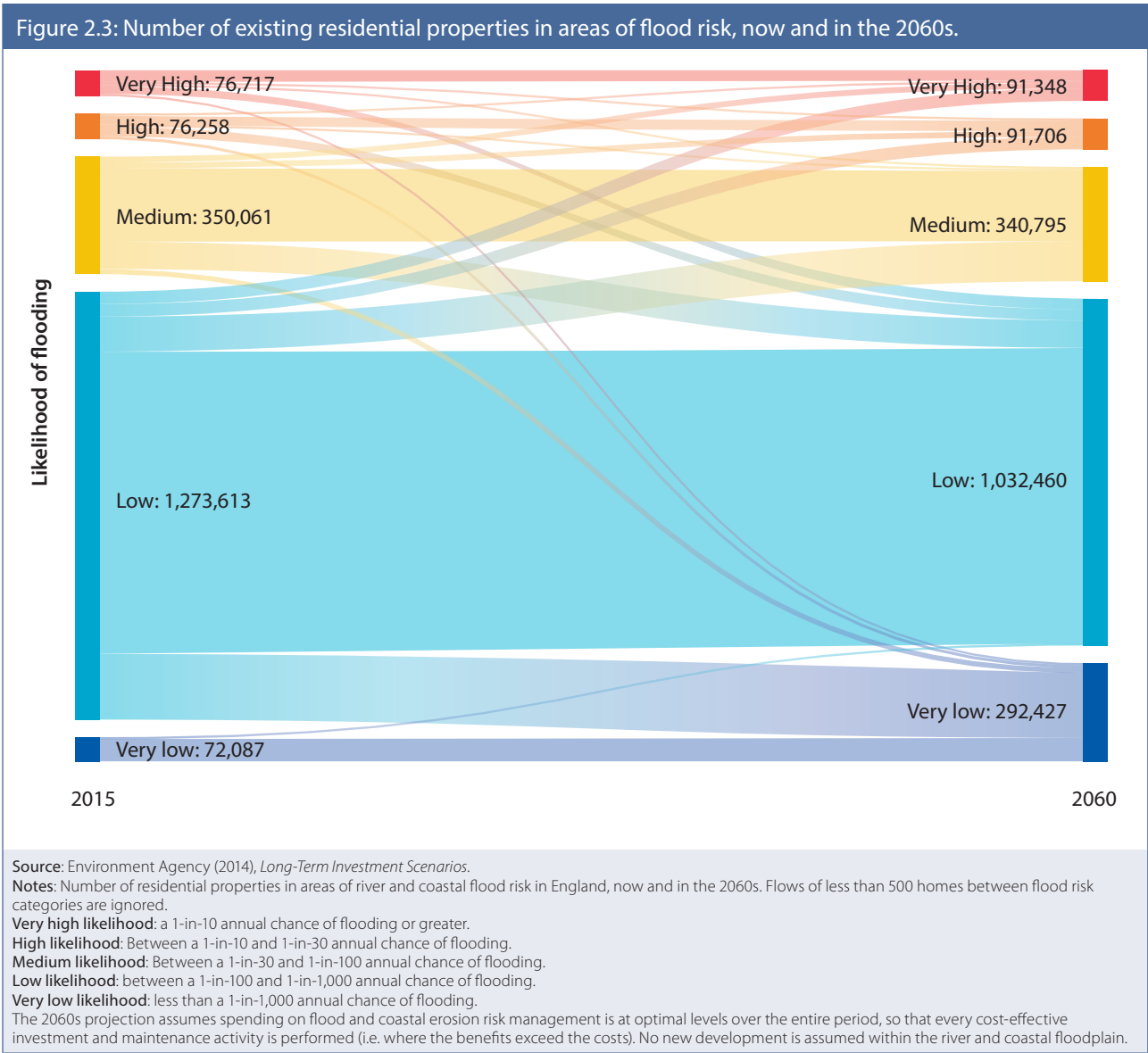
¹⁶ Environment Agency (2014, unpublished) *Asset Maintenance Review*.

¹⁷ Mark Worsfold for Infrastructure UK (2014, unpublished).

Despite the planned investment, flooding will remain a real threat to homes and communities across England. LTIS2 suggests that even if investment grows in line with the optimal trajectory, more homes will become at a high risk of flooding in the coming decades. Some already at a high risk of flooding will remain so, and others will fall in to the high risk bracket as the climate changes and as flood defence structures age (Figure 2.3). This is also considered by the ASC to be a best case scenario.

By the 2060s, LTIS2 suggests the optimal levels of spending over the course of the next five decades may reduce the expected annual damages from flooding by between 4% and 24% depending on the extent of climate change. Most of these gains will be due to hundreds of thousands of properties that are already at a relatively low risk of flooding being even better protected. This makes economic sense, as these investments yield the greatest overall flood risk benefit per pound spent.

However, the number of properties in areas of high flood risk, a 1-in-30 annual chance of flooding or greater, is expected to increase from around 240,000 now to 280,000 by the 2060s.¹⁸ This will be the case even if all cost-effective flood defence schemes are built over the coming decades, and all existing flood defence assets are optimally maintained and renewed. It also assumes that the planning system controls new development to the extent that there is no net increase in flood risk resulting from new development (see Section 2.3.3).



18 Environment Agency (2014). The number of residential properties in areas of high flood risk is projected to increase from around 153,000 currently to 183,000 by the 2060s, see Figure 2.3.




A more realistic assessment might suggest that there will be at least some increase in flood risk resulting from development. If so, LTIS2 will underestimate the number of homes that will be in areas of high flood risk in the future, and further investment would be justifiable. However, in line with the Partnership Funding policy, some of this extra investment will need to be met by contributions from local partners and authorities, as new homes built since 2009 are ignored when national funds are allocated to flood defence projects. This is a sensible precaution, to avoid the national funding formula inadvertently encouraging building on the floodplain in order to secure more taxpayer money over time for local flood defence projects.

There are currently no plans to address the increasing number of homes and businesses in high flood risk areas. LTIS2 illustrates that there will be a limit to how much investment that can be justified in improving flood defences at the community level. At a more localised level, it is possible to prevent flooding, or minimise the damages, by homeowners installing property-level protection and resilience measures. Households could also be helped to relocate away from high risk areas.

However the current rate of take-up of PLP measures is very low. Under the six-year investment plan, only 1,800 homes¹⁹ will be fitted with PLP measures out of a cost effective potential of around 120,000.²⁰ At the current pace, it would therefore take 400 years to exhaust the cost-effective potential to manage flood risk through property-level measures. This issue is discussed further in a section dedicated to the management of residual flood risk, and the opportunities presented by the introduction of the Flood Re subsidised insurance scheme (Section 2.3.4).

RECOMMENDATION 2: Defra should take steps to address the increasing number of homes and other properties expected to be at high flood risk in the coming decades, publishing a strategy within a year of this report. Full use should be made of the opportunities presented by the Flood Re subsidised insurance scheme to encourage households in high flood risk areas to take steps to reduce the potential for flood damage.

2.3.2. Surface water flood management

Is there a plan?		The NAP refers to a number of policy mechanisms that aim to manage local flood risk from surface water and sewers.. Measures include increasing the uptake of SuDS and implementing the local flood risk management arrangements established under the 2010 Flood and Water Management Act.
Are actions taking place?		The Environment Agency published in December 2013 an updated Flood Map for Surface Water (uFMfSW). Ofwat have produced a Drainage Strategy Framework to inform water company planning. However, some actions have been revised, particularly Defra's decision not to implement the SuDS provisions in the Flood and Water Management Act, but instead rely on strengthening the planning system.
Is progress being made in managing vulnerability?		Trends in urban infill development and impermeable surfacing are likely to be increasing surface water flood risk. Many policies are either not being enforced, or implemented, or have been weakened. The lack of monitoring and reporting of activity at both national and local levels makes it difficult to assess what is being done to manage local flood risk.

¹⁹ Environment Agency infographic summarising the six-year investment plan, see: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/381747/6361_EA_SR_FCRM_Infographic_PF_Nov14_v8_Ir.jpg

²⁰ ASC (2012) *Climate change – is the UK preparing for flooding and water scarcity?* <http://www.theccc.org.uk/publication/climate-change-is-the-uk-preparing-for-flooding-and-water-scarcity-3rd-progress-report-2012/>. Assumes there are around 120,000 homes within the 190,000 total number of properties where PLP would be cost-effective, based on the general ratio of residential properties to the overall number of properties in flood risk areas.

Following the 2007 floods a number of policy mechanisms were introduced to improve the management of local flood risk. The 2010 Flood and Water Management Act created lead local flood authorities (LLFAs). LLFAs have duties to develop and maintain a local flood risk management strategy, to investigate flood incidents, and to develop registers of local flood and drainage assets.

Widespread flooding in 2007 damaged 55,000 properties, with the majority of damage blamed on drains and sewers being overwhelmed by heavy rain.²¹ The floods highlighted that traditional piped sewer systems cannot readily be adapted to deal with increased rainfall, particularly in densely urban areas. Half of the national sewer network is reported to be currently at or beyond capacity.²² Without additional action being taken, it is estimated that a combination of climate change, population growth and urban infill development will increase the likelihood of sewer flooding by around 50% over the next few decades.²³

Sustainable drainage systems - such as soakaways, permeable paving, ponds and swales - slow down and store water, to avoid sewer networks being overwhelmed during periods of heavy rainfall. SuDS also deliver a range of other benefits, such as improved water quality, amenity, and biodiversity, and can help to counteract the urban heat island effect.

The Pitt Review made a number of recommendations on how to improve the management of local flood risk.²⁴ These included:

- Introduce national standards for sustainable drainage systems in new development.
- Establish a consenting scheme that will ensure SuDS schemes are designed to high standards, and their long-term maintenance is ensured through them being adopted by local authorities or water companies.
- Remove the automatic right for new development to be connected to public sewers for surface water run-off.
- Unitary and county councils should take a leadership role in bringing together national and local partners involved in managing local sources of flood risk in the area, and to together develop local flood risk management plans.
- Establish local oversight and scrutiny committees to review plans and call to account those bodies involved in managing local flood risk.

The Government implemented many of the Pitt Review recommendations in relation to local flood risk.

- The 2008 Planning Act changed Permitted Development Rights. Householders now need to seek planning permission if they propose to cover more than 5m² of their front gardens with impermeable paving.
- The 2010 Flood and Water Management Act established 152 lead local flood authorities (the unitary or county council in each area, as Pitt recommended). Statutory roles were introduced to identify key flood management assets and investigate flood incidents. Defra provided LLFAs with £36 million a year to deliver these new duties.

²¹ Environment Agency (2009) *The costs of the summer 2007 floods in England*. Project SC070039.

²² Defra (2011) Commencement of the Flood and Water Management Act 2010, Schedule 3 for Sustainable Drainage Impact Assessment, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/82428/suds-consult-annexf-ia-111220.pdf

²³ Mott MacDonald (2011) for Ofwat *Future impacts on sewer systems in England and Wales*, http://www.ofwat.gov.uk/sustainability/climatechange/rpt_com?01106mottmacsewer.pdf

²⁴ Sir Michael Pitt (2008) *Learning lessons from the 2007 floods*, http://webarchive.nationalarchives.gov.uk/20100807034701/http://archive.cabinetoffice.gov.uk/pittreview/the-pittreview/final_report.html

- In 2012, the National Planning Policy Framework included requirements for local planning authorities to prioritise SuDS when scrutinising development applications.
- In 2013, Ministers made clear that they expect water companies to develop Drainage Strategies to inform their business planning and future delivery, so that they manage flood risk and pollution incidents in a changing climate. As a result, water companies have committed to reduce the number of properties affected by sewer flooding by 33% over the forthcoming Asset Management Plan period (AMP6, 2015-2020).

Progress has been slow in implementing local flood risk management arrangements. Local authorities are constrained by resources, including for enforcement of planning controls. The latest published data show local flood risk management strategies have still not been finalised by five out of six LLFAs. The requirement for SuDS in new development has been significantly weakened, with key findings of the Pitt Review ignored.

- **Front gardens in urban areas continue to be paved over.** The proportion of urban front gardens that are paved over jumped from 28% in 2001 to 48% in 2011. Only 4% of all residential paving sales in England were of permeable design in 2013.²⁵ Almost all the surfaces being used are therefore probably impermeable, such as concrete block paving and asphalt. This is despite changes to planning regulations introduced in 2008 to limit the use of impermeable surfaces.
- **The SuDS provisions agreed by Parliament in the Flood and Water Management Act have since been significantly weakened.** Following repeated delays, the Government announced in December 2014 that the SuDS provisions in the Act would not be introduced. A revised approach was announced based on strengthening the planning system, to create an 'expectation' that major planning applications (i.e. those of ten dwellings or more) would include SuDS. The ASC has made clear to the Environment Secretary its concerns about this policy.²⁶ The approach is unlikely to lead to a significant increase in SuDS uptake because the barriers identified by the Pitt Review have not been addressed. Developers retain their automatic right to connect new homes to the public sewerage system, with no regard given to their capacity. Who will pay for, and perform, maintenance on proposed SuDS will still need to be decided on a case-by-case basis, with plans shelved if no agreement can be reached. The NPPF has since 2012 stated that local authorities should give priority to SuDS, but in an ASC analysis of 100 planning applications in areas of flood risk, less than 15% proposed SuDS measures.²⁷ There is no ongoing monitoring at a national level of the uptake of SuDS, nor of the effectiveness of final designs in managing run-off from new developments. This will make it difficult to test whether the new approach, that began in April 2015, is having the desired impact. There will also be an absence of evidence to support options for stronger intervention, should that be necessary.

²⁵ ASC (2014) *Managing climate risks to well-being and the economy*, www.theccc.org.uk/publication/managing-climate-risks-to-well-being-and-the-economy-asc-progress-report-2014/

²⁶ See: www.theccc.org.uk/publication/letter-consultation-on-delivering-sustainable-drainage-systems/ and www.theccc.org.uk/publication/letter-further-measures-needed-to-promote-sustainable-drainage-in-new-development/

²⁷ ASC (2014).

- **Lead local flood authorities are not sufficiently resourced, and progress is slow.** Whilst some of the new roles for LLFAs are statutory, the core task of managing and reducing flood risk is not. Even where statutory roles are specified, there is scope for LLFAs to determine the level of activity required to meet them. One-third of local authorities responding to a 2012 survey said at least some of the funding provided by Defra had been allocated to other council services.²⁸ The Act set no deadline for statutory summaries of the local flood risk management strategy to be published. As a consequence, only five out of 152 LLFAs had published strategies by April 2013. This had increased to 24 by April 2014, but this remains less than one-sixth of all LLFAs in England. Defra ministers have written on three occasions to LLFAs to encourage faster progress, including to state their desire for strategies to be completed and published by the end of December 2014. Results due out later in 2015 are likely to show an increase in the number of finalised strategies, but with more than half still outstanding.²⁹ Defra's grants to LLFAs have been reduced, by £5 million for 2015/16.
- **Local partners are not yet being held accountable for managing local flood risk.** The Pitt Review recommended that local oversight and scrutiny committees be established, or existing ones tasked, to make sure appropriate flood risk management actions are being taken by local partners. There is very little evidence that this is happening, with only isolated examples of committee minutes mentioning flood risk in an online search.
- **It is unclear to what extent water companies will employ SuDS to reduce sewer flooding over the next five years.** Water companies have agreed to reduce the incidents of sewer flooding by 33% over the AMP6 period. Whilst Ofwat will monitor whether agreed performance outcomes have been delivered, the measures water companies take to achieve those outcomes will not be known. This means it will not be possible to assess the extent to which water companies are managing sewer flooding by deploying SuDS. This is preferable as SuDS are more readily adaptable to increasing levels of rainfall than traditional piped sewers, and also deliver a range of co-benefits to the built and natural environments.

Defra has commissioned an evaluation of local authority implementation of the Flood and Water Management Act. The evaluation will review the extent to which local strategies, and scrutiny arrangements, meet the requirements set by the Act and what the Pitt Review intended. It will consider capacity and efficiency issues, and the overall arrangements that are now in place for managing local flood risk.³⁰

RECOMMENDATION 3: Defra should (a) amend in this Parliament the 1991 Water Industries Act in order to remove or make conditional the current automatic right to connect new development to public sewers and (b) work with local government representatives to improve local flood risk management arrangements. Both elements should be part of an action plan to tackle surface water flood risk, to be published by Defra within a year of this report.

RECOMMENDATION 4: DCLG should by the time of the ASC's next report in 2017 (a) make water companies statutory consultees on all planning applications that have implications for the public sewer network; (b) put in place a process for monitoring and evaluating the effectiveness of planning policy in (i) achieving a high uptake of SuDS in new development and (ii) limiting the paving-over of front gardens with impermeable surfaces.




²⁸ *Ibid.*

²⁹ From informal discussions with Defra officials.

³⁰ See: <http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=19219>

RECOMMENDATION 5: Ofwat should require each water company to report on the area of land where above-ground SuDS, including permeable paving, has been installed over the current Asset Management Plan (AMP) period to 2020, as part of delivering the industry-wide commitment to reduce sewer flooding incidents by 33%.

2.3.3. Avoid inappropriate development in flood risk areas

Is there a plan?	 Green	<p>National planning policies that aim to avoid inappropriate development in areas of flood risk have been in place since at least December 2006. The policy (PPS25) was carried forward in the National Planning Policy Framework published in March 2012.</p> <p>The NPPF expects local authorities to produce a Local Plan to guide new development. This should be informed by a Strategic Flood Risk Assessment.</p> <p>Locations at low or no flood risk should be given priority for new development over areas of high risk (the 'sequential test'). Only where there are no available or appropriate alternative sites should development be allowed within flood risk areas.</p>
Are actions taking place?	 Green	<p>Local authorities are carrying out Strategic Flood Risk Assessments that include climate change allowances identified by the Environment Agency. Most local authorities are explicitly applying the sequential test in their strategic allocations.</p> <p>The Environment Agency provides specific responses to all residential planning applications in the 1-in-100 year floodplain (1-in-200 for areas of coastal flood risk), regardless of the size of the development. 98.5% of residential units within planning applications were refused or amended in line with Environment Agency advice on flood risk grounds in 2014/15.</p> <p>The Agency does not generally provide specific advice on small-scale residential development in the 1-in-1,000 year floodplain. For these applications, standing advice is available.</p>
Is progress being made in managing vulnerability?	 Amber	<p>The rate of new residential development in the floodplain has declined, from 1.3% per year between 2001-2007 to 1% per year since 2008. Nearly three-quarters (73%) of floodplain development since 2001 has been located in areas that face a low likelihood of flooding (less than a 1-in-100 annual chance).</p> <p>However, the rate of residential development in areas with a high likelihood of flooding (1-in-30 year or greater) has increased since 2011 and is now higher (at 1.2% per year) than elsewhere. Around 1,500 homes are currently being built per year in areas of high flood risk, with a further 3,100 homes per year in areas of medium flood risk. Together, this makes up around 3% of all development in England per year.</p>

National planning policy on flood risk has been in place for the last 14 years. Local authorities are expected to take a sequential, risk-based approach that accounts for current and future flood risk when strategically allocating land for development.

Local development plans ('Local Plans') are at the core of the land-use planning system in England. Local Plans should set a vision for the sustainable growth of local communities and identify the areas within a district where new development should be allowed, and where it should be constrained. Plans are produced in partnership with local communities, with technical input from expert bodies including the Environment Agency. Under national planning policy it is expected that Local Plans identify a pipeline of land for new housing development for the next five years and for this to be regularly updated.

The National Planning Policy Framework (NPPF) requires local authorities to take account of future climate risks, including from flooding. The NPPF, which was published in March 2012, continued the previous sequential, risk-based policy on flood risk (PPS 25) published in December 2006. PPS 25 was itself a continuation of previous planning guidance (Planning Policy Guidance 25) published in July 2001.

Local Plans should be informed by a Strategic Flood Risk Assessment (SFRA). The SFRA should take account of climate change in levels of flood risk by applying allowances for increases in peak river flow, and sea level rise, as set out in guidance produced by the Environment Agency.³¹

The SFRA should inform the strategic identification of land for development in the Local Plan. The NPPF is clear that locations at higher flood risk should be avoided, and where possible, alternative locations at lower flood risk should be identified. This is known in planning policy as the 'sequential test'.

Where no appropriate alternative sites can be identified, land can be allocated for development but only if buildings are 'safe' for their lifetime and their presence does not increase flood risk elsewhere (the 'exception test'). National planning guidance has been issued to support local authorities in implementing the NPPF, including on how they should apply the sequential and exception tests.

All Local Plans have to go through extensive consultation and be examined by an independent inspector at public inquiry. Objections to the Plan, or to specific policies within it, can be made and heard by the Inspector. Only once the Plan has been through this examination and found to be sound can it be formally adopted.

National planning policy on flood risk is being implemented in Local Plans, meaning that it is unlikely that speculative development applications are being allowed on the floodplain.

Local planning authorities are expected to produce Local Plans in line with the NPPF and the relevant underlying legislation. Despite this, more than two-fifths (39%) of authorities do not currently have an up-to-date adopted plan.³² Furthermore, only 77 local planning authorities out of 340 (23%) have Local Plans that were adopted after publication of the NPPF. Of the 20 local authorities in England that have the highest number of households at risk from river or coastal flooding, 17 do not have post-NPPF adopted plans in place.³³

Where an up-to-date adopted Local Plan is not in place, developers may be more likely to apply for planning permission in unallocated areas knowing that they will have a chance of their application being approved if they appeal against the refusal of permission. Over the last four years, an average of

³¹ See: <https://www.gov.uk/local-planning-authorities-strategic-flood-risk-assessment>

³² Data from the Planning Inspectorate, December 2014.

³³ JBA and LUC (2015) for the ASC *Research to survey local authority action on climate change adaptation*, www.theccc.org.uk/publications/

31% of small-scale residential planning applications (of ten dwellings or less) went to appeal. Around one-quarter of these appeals were allowed, an average of around 1,200 applications per year.³⁴

It is not possible to assess the proportion of applications approved on appeal that were located in flood risk areas without reviewing individual cases. However, Planning Inspectors are required to take account of the policies in the NPPF, including its policy on flood risk, when making decisions on individual applications. As relatively consistent national planning policy on flood risk has been in existence for the last 14 years, it is likely that Planning Inspectors will rule against planning applications for inappropriate development in flood risk areas if taken to appeal. However, this is an area worthy of further exploration.

The available evidence suggests that local authorities are generally applying national planning policy on flood risk in their Local Plans. In a recent ASC survey of 90 local authorities, all the Local Plans reviewed had been prepared in light of Strategic Flood Risk Assessments.³⁵ The Environment Agency had been directly involved in advising on the preparation of the SFRAs. The majority (82 out of the 90) had applied climate change allowances. Most of the post-NPPF adopted Local Plans in the survey had also explicitly applied the sequential test in their strategic allocations of land for development (15 out of 23).

Where development in flood risk areas is considered, national planning policy is clear that it should be safe, resilient and not increase flood risk elsewhere. The Environment Agency plays a key role in advising and scrutinising planning applications on flood risk grounds.

The Environment Agency is a statutory consultee on all planning applications (other than for minor development) in the 1-in-100 year floodplain (Flood Zone 3, 1-in-200 in areas of coastal flooding) and in the 1-in-1000 year floodplain (Flood Zone 2).³⁶ Being a statutory consultee means that the Agency has to be consulted by the planning authority and has 21 days to respond, as well as report annually on its responses in general.

National planning policy guidance states that most residential development is potentially appropriate in Flood Zone 2, except for basement dwellings, caravans, mobile homes and park homes intended for permanent use. An 'exception test' has to be passed for residential planning applications in Flood Zone 3.

The Environment Agency provides specific advice on all residential planning applications in Flood Zone 3, regardless of the size of the development. In Flood Zone 2, the Agency provides specific advice on large-scale residential planning applications (i.e. ten dwellings or more).³⁷ Small-scale residential development in Flood Zone 2 is reliant on the Agency's generic standing advice.

Where the Agency provides specific advice, it will review whether an application has adequately assessed flood risk and put in place measures to ensure the development will be safe, resilient and not increase flood risk elsewhere. Where it has concerns, the Agency may suggest conditions that the planning authority should set if permission is to be granted, or it can formally object. If these concerns are not addressed, the Agency will decide whether to sustain its objection until a final decision is made by the planning authority, or the application is withdrawn by the developer.

³⁴ The number of appeals for major residential planning applications (ten or more dwellings) increased from 571 in 2011/12 to 736 in 2014/15. However, this only accounts for around 5% of all major planning applications across England every year. Data from the Planning Inspectorate, December 2014.

³⁵ JBA and LUC (2015) for the ASC.

³⁶ In Flood Zone 1 (less than 1 in 1,000 year risk of flooding) the Agency is only a consultee in areas with critical drainage problems. Note that the Agency is not a statutory consultee for 'minor' planning applications, such as household extensions, changes of use, advertisements, etc.

³⁷ As well as for all basement dwellings, caravans, mobile homes and park homes intended for permanent use.

Almost all decisions made on planning applications in flood risk areas are in line with the Environment Agency's advice. This appears to be the case even where local authorities do not inform the Agency of the outcome of their objection.

The Environment Agency's advice is adhered to by local planning authorities in almost all cases. In the ASC's 2014 progress report, we reviewed a sample of 4,000 Agency responses to planning applications made between 2009 and 2013.³⁸ Over this four year period there were only 11 applications where a sustained Environment Agency objection was over-ruled by the planning authority. Almost all these instances were in 2009. In most other cases developments were approved on the condition that the Environment Agency's advice was followed by the developer, with a small proportion either refused by the planning authority or withdrawn by the developer.

The Agency reports quarterly on the proportion of residential units within planning applications that were refused or amended in line with Environment Agency advice. For the most recent report available (Quarter 3 of 2014/15) this figure was 98.5%, exceeding the target of 95%.³⁹

As the ASC has previously reported, there is some uncertainty in the outcome for a proportion of Environment Agency objections. This is due to local planning authorities not always informing the Agency of the outcome of their objection. In the ASC's 2014 report, we reported that the Environment Agency was not informed of the outcome in 41% of applications it responded to in 2012.

It is, however, highly likely that the Environment Agency's advice is followed in the majority of cases where the local authority does not inform them of the outcome. The Agency's advice was accurately transposed by planning authorities into conditions set out in the final decision notices in almost all of the 111 applications assessed by the ASC in more detail. This included those applications where the planning authority did not inform the Environment Agency of the outcome.

Where the Agency decides to object to a planning application on flood risk grounds, the main reason is due to poor quality flood risk assessments. In the ASC's 2014 report, we noted that around 10% of the 4,000 planning applications reviewed between 2009 and 2013 did not have a flood risk assessment. The Agency initially objected to a further 25% of applications due to inadequate flood risk assessments over the same period.

Whilst decision notices reflect Environment Agency advice, there is uncertainty as to whether developers are abiding by the conditions set by local authorities when planning permission is given.

No data are available on whether developers are building in compliance with conditions set by planning authorities. Planning authorities are responsible for enforcing planning conditions, but there is no systematic approach to recording checks and enforcement where it takes place.

The standard conveyancing searches conducted as part of a house purchase would not ordinarily establish whether a home in a flood risk area was built against the Environment Agency's advice. Searches would also not normally discover whether conditions set by the planning authority were implemented by the developer.

³⁸ ASC (2014).

³⁹ Environment Agency (2015) *FCRM Outcome Measure Progress Report - Quarter 4 2014-15*.

The implementation of national planning policy has ensured that the majority of new development on the floodplain has been within lower risk areas. However, around one-quarter of new homes built on the floodplain were in areas that are at a high or medium level of flood risk.

According to the ASC's analysis, more than 251,000 new homes have been built in the floodplain between 2001 and 2014.⁴⁰ This makes up around 12% of all new residential development in England over that time.

Nearly three-quarters (73%) of floodplain development has been in areas that are at low risk or well protected by existing river and coastal flood defences (i.e. areas with between a 1-in-100 and 1-in-1000 annual chance of flooding). These tend to be major population centres located on the river floodplain or on the coast that have a reasonably high standard of flood defences in place.

However, 27% of floodplain development since 2001 (68,000 new homes) has been in areas with a 1-in-100 or greater annual chance of flooding. Around 23,000 new homes (9% of floodplain development) have been built in areas with a high likelihood of flooding, with a 1-in-30 or greater annual chance of flooding from rivers or the sea, even where flood defences are in place. This is the highest category of flood risk shown on the Environment Agency's maps, and is where flood insurance is least likely to be available and affordable. New properties built in these areas will not be eligible for the Flood Re subsidised insurance scheme. This is an appropriate safeguard but in extreme cases may leave the owners of these new homes with uninsurable risks.

Development in high risk parts of the floodplain appears to be mostly occurring outside major population centres, in more sparsely populated parts of the country. Community-level flood defences are more difficult to justify on cost-benefit terms in these areas. They are therefore likely to remain poorly protected and at increasing flood risk with climate change. Places already with a relatively high proportion (between one-quarter and three-quarters) of residential properties in high risk areas include parts of Kent, the Isle of Wight, Cornwall and rural Devon, the outer Thames valley, Norfolk and Suffolk, North Yorkshire, Northumberland and parts of the north-west. Data for new development in each local authority area are available in an annex to this report on the CCC's website.

The annual rate of development on the floodplain has been higher than elsewhere, although it has remained broadly stable in recent years.

Between 2001 and 2007, the average rate of residential development⁴¹ on the floodplain was higher than the rate outside floodplain areas, at 1.3% per year compared to 0.8% per year. The average rate both inside and outside floodplain areas fell between 2008 and 2010, to 1% and 0.6% respectively. This was due to the reduction in construction activity following the global financial crisis (Figure 2.4).

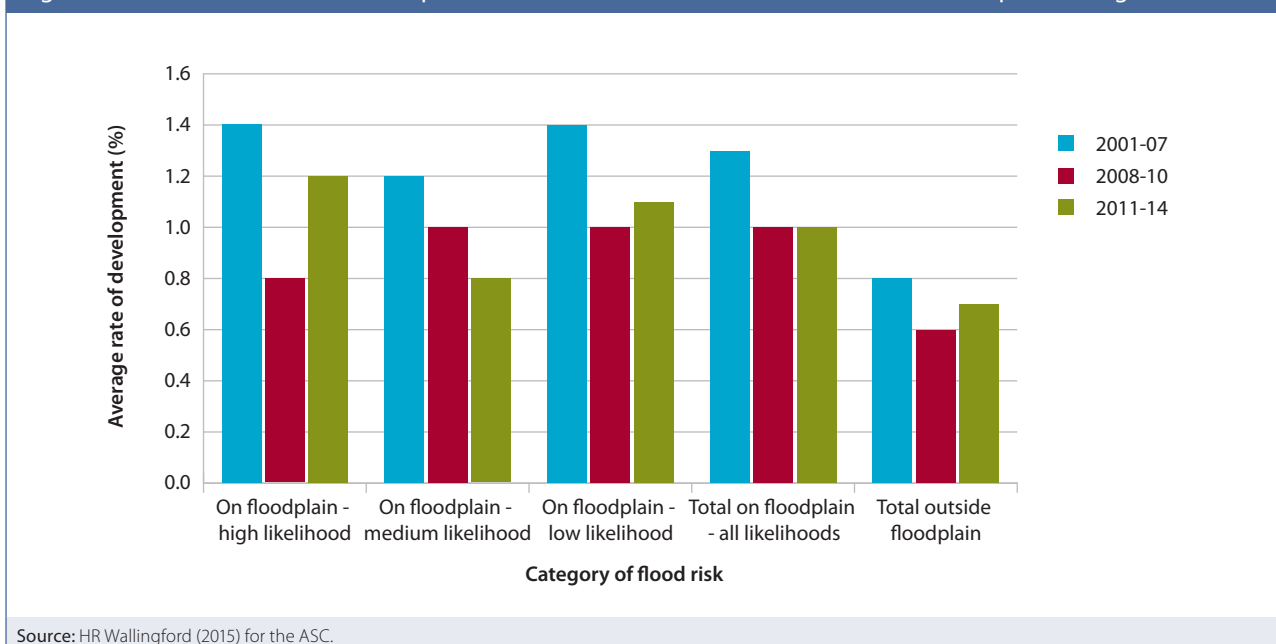
As the UK economy started to recover the rate of new development outside floodplain areas picked up slightly, to average 0.7% a year between 2011 and 2014. The rate has, however, remained broadly flat within the floodplain at around 1% per year. This suggests that development has been restricted to some degree on the floodplain as a result of adherence to planning policy. However, the annual rate of development on the floodplain remains higher than outside it.

The average rate of development in areas of high flood risk was 1.4% per year between 2001 and 2007, greater than the average for the floodplain as a whole. The rate declined in line with the recession between 2008 and 2010, but has since risen to 1.2% per year between 2011 and 2014. However, the

⁴⁰ The ASC's 2012 progress report included original spatial analysis of the number of addressable properties built in areas at risk of (a) river or coastal flooding, (b) coastal erosion and (c) surface water flooding between 2001 and 2011. This analysis has been updated for the purposes of this report. For river and coastal flooding, the Environment Agency's 2014 National Flood Risk Assessment (NaFRA) flood hazard data was used. This defines four categories for the annual chance of the onset of flooding from rivers or the sea, after accounting for the presence of flood defences: high (greater than 1-in-30 annual chance), medium (1-in-30 to 1-in-100 annual chance), low (1-in-100 to 1-in-1,000 annual chance) or very low (less than 1-in-1,000 annual chance). The areas at high and medium likelihood broadly correspond to Flood Zone 3 and the area at low likelihood to Flood Zone 2. For the purposes of this chapter, the term 'floodplain' refers to the combined area at high to low likelihood (i.e. excludes the 'very low' category which broadly corresponds to Flood Zone 1). For further details of the technical method taken see HR Wallingford (2015) for the ASC. www.theccc.org.uk/publications/

⁴¹ Meaning the proportional growth in housing stock in each area.

Figure 2.4: Rate of residential development inside and outside the river and coastal floodplain in England.



average development rate in areas of medium flood likelihood (1-in-30 to 1-in-100 annual chance) has consistently declined, from 1.2% per year between 2001 and 2007 to 0.8% per year between 2011 and 2014.

Continued development in flood risk areas will increase the consequences of flood events, even before accounting for the impacts of climate change.

Building new homes behind flood defences adds to risk and will increase expected annual flood damages. This is because flood defence structures can fail or design standards can be exceeded by severe events. It also commits future generations to increasing flood protection costs.

As noted in Section 2.3.1, the number of existing residential properties located in areas of high risk is expected to increase from around 153,000 now to 183,000 by the 2060s, due to a combination of climate change and deterioration in flood defence asset structures. At the current rate, continuing development in areas of high risk is adding an extra 1,500 homes per year to these numbers.

This new development is almost certain to be complying with planning policy, which requires consideration of the impact of climate change and for the exception test to be passed to ensure the development is safe. However, if these new homes are being located in areas where it is uneconomic to improve flood protection levels, it will lead to an increase in the number of residential homes in areas of high flood risk in the 2060s from 183,000 to at least 258,000. This would lead to a two-thirds increase in the current number of homes in areas at high flood risk.

This assumes that no new homes built in medium flood risk areas move in to the high flood risk category with climate change. In reality a further 3,100 new homes per year are currently being built in areas with a medium flood likelihood. Some of these parts of the floodplain can expect to be at a high likelihood of flooding over the next few decades due to projected increases in peak river flows, and with sea level rise (see Figure 2.3).

The potential consequences of new development being located in the floodplain are ignored for the purposes of long-term flood risk management plans and investment strategies.

As discussed in Section 2.3.1, the optimal investment path in the Environment Agency's long-term investment scenarios assumes that there is no net increase in flood risk resulting from new development, and no additional flood protection costs.




Both assumptions could be challenged as overly optimistic. National planning policy is generally being implemented by local authorities, so for now it can be assumed that new homes in areas of high flood risk have safeguards in place to avoid flood damage. However, new homes built behind flood defences are less likely to have as strict planning conditions as those being located in areas of higher risk. This may result in the consequences of flood events increasing should defences be overtopped or fail.

New development will also increase the economic rationale to invest in flood protection. Protecting most major population centres will always be strong, so new development in these areas will not alter flood risk management plans and costs. But new development in lesser populated areas, or at the edges of towns and cities, may increase the justification for flood defence improvements. This will add to future flood protection costs, as well as the economic damages should flooding still occur. The Environment Agency's long-term investment scenarios suggest less controlled development would justify an extra £140 million per year (16%) being spent on flood risk management in England.⁴²

More evidence is needed to explore the relationship between new development and future flood risk. This could be based on reviewing a representative sample of individual developments approved since the publication of the National Planning Policy Framework in 2012, to gather evidence on the steps that have or have not been taken to ensure the development is resilient to flooding for its lifetime.

RECOMMENDATION 6: DCLG and the Environment Agency should by the time of the ASC's next report in 2017 publish an assessment quantifying the impact of new development on long-term flood risk. The evidence from this assessment should be used to inform subsequent Environment Agency long-term investment scenarios.

2.3.4. Residual flood risk to existing properties

Is there a plan?		There is no specific plan or policy to address the increasing number of homes and other properties expected to be in areas of high flood risk in the future (see Section 2.3.1). Flood Re, the forthcoming subsidised flood insurance scheme, will largely remove the financial incentive for high risk households to take action to prevent flooding.
Are actions taking place?		The NAP states that the Government is encouraging the uptake of property-level flood protection measures, with grants available to help pay for household flood protection measures. Schemes to install property-level protection systems in at-risk communities can be proposed by any flood risk management authority, supported by funding from the Environment Agency and Regional Flood & Coastal Committees. Various projects are underway to help address the barriers to the widespread uptake of PLP measures.
Is progress being made in managing vulnerability?		Defra's six-year flood defence investment plan expects to support 1,800 homes using property-level protection measures. At the current pace this means it would take 400 years to protect the 120,000 households where such measures are likely to be cost-effective.

⁴² From data provided by the Environment Agency. A medium emissions scenario with new development factored in would increase the optimal level of expenditure on flood and coastal erosion risk management in England from £860 million per year to around £1 billion per year over the next decade.

There is no explicit policy mechanism in place to accelerate the uptake of property-level flood protection, despite it being a low-regret adaptation measure. Time-limited 'Repair and Renew' grants were announced after the winter storms of 2013/14 to support the affected homes and businesses become more resilient to future events. Although there has yet to be a formal evaluation, take-up has been low with only £1.8 million paid out by January 2015 (supporting around 360 properties of the almost 11,000 that flooded).⁴³

The Environment Agency's long-term investment scenarios suggests that even in the best case scenario, the number of properties in areas of high flood risk is expected to increase by around 45,000 by the 2060s. This assumes all cost-effective community-level flood and coastal defences are built and there is no new development on the floodplain. The term 'residual risk' is used to describe the extent of flooding that is still expected despite the existence of flood and coastal defences. At the moment the Government's approach to managing residual risk focuses on improving forecasting and warning services, and emergency response arrangements, in order to limit loss of life and allow people time to prepare for the onset of flooding.

Residual risk can also be managed by preventing flood water entering buildings through the use of property-level protection measures (e.g. flood gates and airbrick covers). Damages can be minimised by the fabric of buildings being made more resilient to flood water (e.g. tiled flooring and positioning electric sockets above potential water levels; termed 'resilient repair' if done in response to a flood event). Flood resilient buildings can be dried out, repaired and returned to use within weeks rather than many months. This decreases costs, and insurance claims, including by reducing the length of time alternative accommodation is needed. The benefits of PLP outweigh the costs by a factor of five or more for homes at a very high risk of flooding (a 1-in-10 annual chance of flooding or greater). Overall, the cost-effective potential for PLP measures in England is estimated to be 190,000 properties, including around 120,000 households.⁴⁴

Grants for households wishing to fit PLP measures are available under the normal Partnership Funding rules. In addition, 'Repair and Renew' grants worth £5,000 have been made available to each home or business affected by the storms in the winter of 2013/14. Around 2,000 properties in 100 communities now benefit from PLP measures funded by government grants between 2007 and 2011.⁴⁵ Between 2012/13 and 2014/15, a further 1,400 properties received funding of £5.8 million for PLP measures.

Feedback from companies selling flood products suggests that almost all their business in the household market is reliant on grants. However, grants may not meet the full costs of measures and some investment by households may be required. Installers say that households have proven reluctant to spend even relatively modest amounts of their own money, such as £500, to top-up the £5,000 in repair and renew grants available in order to pay for measures.

As well as financial barriers, there are a range of technical and psychological barriers to the widespread take-up of PLP. For PLP to be effective the right suite of products need to be identified by surveyors, based on the individual characteristics of the property. The products need to be installed correctly, maintained appropriately, and where necessary, fitted by the homeowner as instructed in advance of each flood event. Failure at any stage in this process may render the products ineffective. Households are concerned about the visual impact of product fittings on the outside of their homes (e.g. attachment points for flood gates), and may lack confidence that the measures will work in flood conditions.

⁴³ See: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/397470/RFI7083_20150121_Flood_grant_schemes_Redacted__2__amended.pdf

⁴⁴ ASC (2012).

⁴⁵ From data provided by Defra.

To address this, manufacturers are developing flood resistant doors that can be permanently installed. Defra is working to build capacity amongst flood surveyors and installers.⁴⁶ There is also work underway to define standards for flood resilient approaches and materials in retrofit and new build projects. Defra has been working with DCLG on a new standard, BS85500, to replace guidance published in 2007.⁴⁷ A draft of the new standard was open for consultation at the time of writing. Defra has also commissioned a research project to explore ways to minimise the additional cost of making a property more resilient to damage from floodwaters.⁴⁸

Households also appear reluctant to fit products for fear of what it might mean for their costs of flood insurance. Whilst a reduction in premiums might be possible if PLP measures are fitted, households are concerned that investing in PLP might flag their property to insurers as particularly at risk. The Association of British Insurers has written an open letter to try to alleviate this concern.⁴⁹

Flood Re offers the potential to accelerate the uptake of PLP measures. However, as currently designed, the scheme is likely to have the opposite effect and be counter-productive to the long-term management of flood risk. Flood Re is set to provide too much subsidy to too many people, largely removing the financial incentive for flood damage to be avoided by high risk households. The decision to extend subsidies to the most expensive 1% of homes was a retrograde step, increasing costs and reducing further the scheme's already poor value for money.⁵⁰

A series of voluntary agreements between the UK Government and the Association of British Insurers (the 'Statement of Principles' agreements) have helped in the past to make flood insurance available in high risk areas. In 2008 the ABI and the Government agreed to extend the Statement of Principles for a final five-year period. The final statement said that by 2013, the "conditions should be in place to enable the insurance market to be able to provide flood insurance to the vast majority of households and small businesses efficiently."⁵¹

The Statement of Principles did not control prices. It only obliged ABI members to continue to offer cover to existing customers if the risk of flooding was below a 1-in-75 annual chance, or where improved defences were planned within five years. The ABI and the Government agreed that this limited safeguard would be removed and a free market for flood insurance would emerge by mid-2013. In preparation for this, insurers began to impose risk-reflective terms on some high risk customers. A survey of ABI member insurers in 2010 found 22% of households in flood risk areas were already paying a risk-reflective price.⁵²

However, in 2012 the Association of British Insurers began to claim that a free market might leave "200,000 high risk homes struggling to afford cover".⁵³ The ABI had developed 'Flood Re', a proposal that would see flood insurance underwritten by the government and subsidised by a levy on other premiums. Under the proposal, household flood insurance in high risk areas would be capped according to council tax bands. By ceding the highest risk policies to a separate pool, insurance company profits would be protected from the annual volatility of flood claims. As such Flood Re is an important and profitable adaptation measure for the industry.

46 See: <http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=19220>

47 DCLG (2007) *Improving the Flood Performance of New Buildings*, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/7730/flood_performance.pdf

48 See: <http://sciencesearch.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&ProjectID=19221&FromSearch=Y&Publisher=1&SearchText=low%20cost%20resilience&SortString=ProjectCode&SortOrder=Asc&Paging=10#Description>

49 See: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/357820/140805_ABI_Otto_Thoresen_to_Penny_Mordaunt_Repair_and_Renew_Grant.pdf

50 Defra (2015) *Cover note to the impact assessment for Managing the Future Financial Risk of Flooding*, http://www.legislation.gov.uk/ukdsi/2015/978011134047/pdfs/ukdsiod_978011134047_en_001.pdf

51 Government, ABI (2008) *Revised statement of principles on the provision of flood Insurance*, <https://www.gov.uk/government/publications/provision-of-flood-insurance-revised-statement-of-principles>

52 ABI (2010) *Research Brief: Under-pricing of the flood element of home insurance for domestic customers at significant risk*.

53 See: <http://www.bbc.co.uk/news/business-16794696>

Alleviating flood risk will almost always be more cost-effective than bearing flood damage. Flood Re doesn't prevent flood damage occurring, but is a formal means to pass the costs of flood damage to high risk homes on to other policyholders. Due to the costs of reinsuring a pool of only high risk policies, Flood Re's value for money is very poor. According to the Government's latest figures, Flood Re will achieve 30 pence in benefits per £1 of economic cost. In contrast, managing flood risk using property-level protection measures achieves a return of at least £5 in benefits per £1 spent for homes in very high risk areas. The Government estimates that in the worst case scenario, of a full and rapid transition to a free market, 16,000 households might find flood insurance unavailable or unaffordable.⁵⁴ This would lead to an increase of £5 million in uninsured flood damages to UK households per year. To counter this, a £180 million levy to subsidise insurance for 350,000 households is proposed.

Whilst there is no economic rationale for Flood Re, the policy is intended to be a time-limited, transitional measure to support high risk households to adjust to increasing insurance costs. The Government proposes to gradually withdraw subsidies and allow the price of insurance for those households in the scheme to rise, initially by the rate of inflation. This allows long-term decisions to be made by households, including to alleviate the potential for flood damage using PLP measures if they wish.

The more that Flood Re can do to spur additional flood risk management by high risk households the better it will be in value for money terms. The enabling legislation in the 2014 Water Act limits Flood Re's lifetime to a maximum of twenty-five years, and places a duty on the Flood Re administrator to prepare a plan for the transition to a free market over the scheme's lifetime. The transition plan is due for publication later in 2015, within three months of Flood Re Ltd being formally designated as the scheme administrator (due in July 2015 at the time of writing). The transition plan is a key document, as it will set the framework for whether, and to what extent, Flood Re will encourage or require high risk households to address their flood risk as a condition of benefiting from subsidised flood insurance. The ASC wrote in February 2015 to Flood Re's chief executive with five ways to improve the scheme's design. The proposals would promote flood risk reduction, lower Flood Re's costs, and improve value for money but no changes have yet been made.⁵⁵

As a minimum, households within the scheme need to know that their home is at risk, and that over time they can expect the costs of their flood insurance to rise. Under the Act, the scheme administrator has a duty to provide insurers with generic information on flood risk, and about Flood Re, to pass on to their high risk customers. Households will also need to know how quickly they can expect prices to rise, and what measures they might take to allow flood insurance to remain affordable once Flood Re is withdrawn. However, there is currently no compulsion for insurers to pass this information on to their customers. Insurers may be reluctant to pass this information on in case it prompts customers to shop around and buy a policy from a competitor with a lower flood risk assessment for their property. This might lead to lost business across a range of product lines bought by customers in flood risk areas.

The default position is that Flood Re will achieve a transition by steadily increasing the cost of flood insurance each year so that more and more high risk homes pay a risk-reflective price. The ASC has consistently argued that Flood Re should focus as much as possible on helping high risk homes to adapt their properties so that insurance can be secured without Flood Re's help. Otherwise Flood Re will only postpone the affordability issue, and not address it. If flood risk remains unaddressed, the same voices calling for Flood Re in recent years and that will benefit from the subsidies – insurance companies and flood risk communities – will argue that the transition cannot proceed because the underlying risk remains. This would prolong the system of subsidies and the poor value for money this entails.




⁵⁴ Defra (2014) *Flood Re Impact Assessment*, https://consult.defra.gov.uk/flooding/floodreinsurancescheme/supporting_documents/Flood%20Re%20Impact%20Assessment.pdf
⁵⁵ See: www.theccc.org.uk/publication/letter-designing-flood-re-to-encourage-flood-risk-reduction/

RECOMMENDATION 7: Flood Re's transition plan, required within three months of Flood Re Ltd. being formally designated the scheme administrator, should include clear proposals for how the scheme will promote flood risk alleviation amongst high risk households.

2.3.5 Heat-related health impacts

See Chapter 4 – Healthy & Resilient Communities.

2.3.6. Water demand in the built environment

Is there a plan?		Water resources management plans require water companies to manage the risk of supply-demand deficits looking 25 years ahead. These inform five-year business plans agreed with the regulator, Ofwat, that deliver reductions in demand through improvements in water efficiency and behavioural change. Building Regulations and the Code for Sustainable Homes put in place relatively strong requirements for water efficiency in new buildings.
Are actions taking place?		Ofwat has made changes to the regulatory framework to remove the previous bias towards water company investment in large capital projects. This should prompt a greater focus on demand management. Water companies appear to be prioritising demand management measures in long-term plans, although the latest plans may underestimate the opportunities available to reduce demand further in the future. The completion of the NAP action to coordinate timings of the price review and water resources management plans to ensure they are joined-up has been delayed until the 2019 Periodic Review.
Is progress being made in managing vulnerability?		Water consumption per person and leakage losses are falling. The proportion of households with water meters is increasing. Many new homes are being built to higher standards than those set in Building Regulations, minimising the added pressure on water resources.

The Climate Change Risk Assessment identified a high level of uncertainty associated with the risks of future water availability, but with some risk of a deficit in most regions in the near-term. In the face of large uncertainties, demand management represents a low-regret adaptation strategy.

Demand management measures, such as low-flow showers and taps, basic rainwater harvesting, and dual flush WCs, are low-regret options to take in the face of large uncertainties in future water availability. These measures provide benefits today, and against any future deficit between supply and demand, and defer or delay the need for costly investment in supply infrastructure.

One important lever for demand management is effective pricing, which is needed to act as a signal of the value and availability of water to consumers. A necessary condition for effective pricing in public water supply is metering. Water meters allow customers to pay for the water they use, rather than a flat rate tied to house size or value. Water demand measures have the potential to reduce the costs of living amongst households on meters.

Over the past decade consumption per person has fallen and the proportion of households with water meters has increased.

Consumption per person in England has fallen from 155 litres per day (l/day) in 2003 to 141 l/day in 2013. This has been supported by an increase in water metering. The proportion of households in England that are metered has increased at a rate of about 2% a year since 2000, and around half of all households now have a water meter.⁵⁶

Under current legislation, universal metering can only be considered by water companies in areas that are designated as seriously water stressed. The costs and benefits of installing them universally elsewhere are not clear cut. In 2013 the Environment Agency updated the methodology used to determine water-stressed areas to include the effects of climate change. However, due to other changes in the methodology, this means there are now two fewer water companies in England that are defined as at serious water stress.

The Walker Review concluded that a systematic rollout of metering could save between £600 million and £1.5 billion nationally compared to the current system.⁵⁷ However, the Government has been concerned about the impacts of metering on water affordability for some customer groups. Without some flexibility in the tariff, large households in properties with low rateable values would see their bills rise to reflect their actual water consumption. To address this issue, water companies are trialling and implementing more innovative approaches, such as seasonal tariffs and rising block tariffs, as well as social tariff schemes.

Changes to the water resource management framework have placed a greater emphasis on demand management. If plans are implemented, this will help to maintain momentum in reducing water demand and decrease the potential for supply-demand deficits. However, there is scope for companies to be more ambitious on demand management in longer-term plans.

Water companies are required to publish water resources management plans (WRMPs) that set out how they will manage and develop water resources to balance supply and demand in the future. The WRMPs are produced every five years and look 25 years ahead, with the latest set of plans being published in 2014. Water companies are required to take account of climate change within these plans.

Water companies also submit water resources business plans (WRBPs) to Ofwat as part of a five-yearly process known as a Periodic Review. These are used by Ofwat to set limits on the price customers pay for the supply of water and treatment of wastewater, the outcomes companies must deliver, and the incentives in place to support delivery. Ofwat uses the WRMPs to assess the companies' supply-demand balance and the work they need to undertake as part of the Periodic Review. The latest Periodic Review, PR14, was completed in December 2014. This sets price limits for the next Asset Management Plan period, AMP6, from 2015 to 2020.

For PR14, Ofwat made a number of changes to the system of rewards and penalties to encourage water companies to deliver important outcomes to customers for least cost. The new regulatory system also removes the bias towards investing in big capital projects, treating operational (ongoing or 'opex') and capital investment ('capex') on a more equal basis.

These changes have led to a slight increase in ambition on demand management. On the basis of plans set out by water companies, Ofwat estimates the proportion of households with water meters in England and Wales will increase from 49% in 2015 to 61% in 2020. Around three-quarters of water companies have also made performance commitments to reduce per capita consumption.⁵⁸ If met,

⁵⁶ Environment Agency (unpublished). *June return historic data*.

⁵⁷ Walker, A. (2009) *The independent review of charging for household water and sewerage services*, <http://www.defra.gov.uk/publications/files/walker-review-final-report.pdf>

⁵⁸ Ofwat (2014) *Setting price controls for 2015-20 – Overview*, https://www.ofwat.gov.uk/pricereview/pr14/det_pr20141212final.pdf

these commitments would deliver reductions in water use of 215 megalitres per day (Ml/day), reducing consumption per person from 141 l/day today to around 137 l/day by 2020.

The long-term plans in Water Resources Management Plans suggest water companies will be prioritising demand-side measures over the next decade. Around 90% of the 300 Ml/day reduction in demand proposed by 2040 will have been achieved by 2025 according to current plans.⁵⁹ From 2025 onwards supply-side measures such as effluent re-use, reservoir construction and the development of new and existing groundwater sources account for nearly all of the proposals to deal with future deficits.

Implementing the demand-side measures in WRMPs would help to lower consumption per person from 141 l/day to around 135 l/day by 2040. This is only marginally below the level that will be reached by 2020 if performance commitments for AMP6 are delivered. Previous analysis by the ASC suggests the uptake of cost-effective water efficiency measures could reduce consumption to 115 l/day.⁶⁰ Empirical trials suggest that water efficiency measures can reduce household consumption by an average 20 to 40 litres per day, which roughly equates to 9 to 17 l/day per person.⁶¹ This suggests greater ambition on demand management is readily achievable.

RECOMMENDATION 8: Ofwat should continue to work with the Environment Agency and water companies to ensure that action is being taken to manage household demand for water. This will require ambitious demand reduction commitments in the next round of long-term water resources management plans, due in 2019, including ensuring sustained increases in metering and a continued reduction in average per person consumption.

Building Regulations include requirements that limit water consumption in new buildings. These have been updated as part of the Housing Standards Review and are being exceeded by developers in many cases.

Since 2010, Building Regulations have included a requirement for all new homes to be designed such that their calculated water use is no more than 125 litres per person per day. This is broadly the same as the average level of consumption per person in existing metered properties.

Some local authorities in their planning policies require more ambitious standards to be met. A survey of 109 local authorities found over half (56%) required new development to be built to a Code for Sustainable Homes star rating of three or above, requiring a calculated water consumption per person of 110 l/d or below.⁶² Around 35% of homes built in 2013/14 received a Code for Sustainable Homes star rating of three or above.⁶³ Previous analysis by the ASC has shown that this standard could be achieved at only a very small cost to developers. The same survey found a further 9% of local authorities had a separate standard for water efficiency.

The Housing Standards Review is rationalising the number of codes, standards, regulations, rules and guidance applied by local authorities to new housing. The Government has set out its proposals to introduce an optional requirement in Building Regulations allowing planning authorities to set this limit at 110 l/d per person where the need for such a requirement can be demonstrated.

⁵⁹ ASC analysis of data provided by the Environment Agency.

⁶⁰ ASC (2011) *Adapting to climate change in the UK – Measuring progress*, www.theccc.org.uk/publication/adapting-to-climate-change-in-the-uk-measuring-progress-2nd-progress-report-2011/

⁶¹ Waterwise (2010) *Evidence base for large-scale water efficiency in homes – Phase II interim report*, <http://www.waterwise.org.uk/data/resources/14/evidence-base-for-large-scale-water-efficiency-in-homes-phase-ii-interim-report.pdf>

⁶² EC Harris (2014) for the Department for Communities and Local Government *Housing Standards Review. Local authority policy survey*, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/353395/013_Survey_Write_Up_5th_August_2014.pdf

⁶³ The actual number of homes built to this standard may be higher as this percentage includes only homes certified at the post construction stage and not those certified at the design stage.

2.4 Conclusions on NAP objectives and actions

The table below summarises progress against the objectives listed within the NAP for the Built Environment theme. In general, the objectives describe a number of processes and list actions by which the resilience of the built environment should be improved.

Of the 61 actions in the Built Environment chapter of the NAP:

- 27 (44%) are completed;
- 31 (51%) are on-track; and
- 2 (3%) have been revised or delayed.

We did not receive an update on the remaining action.

Over half (61%) of actions are time-bound with the remainder classed as 'on-going'.

Table 2.1: NAP objectives and a summary of progress for the built environment theme

NAP objective	Commentary on progress
Objective 1: To work with individuals, communities and organisations to reduce the threat of flooding and coastal erosion, including that resulting from climate change, by understanding the risks of flooding and coastal erosion, working together to put in place long-term plans to manage these risks and making sure that other plans take account of them.	<p>There are ten actions for this objective, all are complete or on track. They mostly relate to the implementation of various aspects of flood risk management policy by Defra and the Environment Agency.</p> <p>Progress is being made with some aspects of flood risk management policy listed under this objective. There is a long-term approach to flood risk management and investment, most recently presented in the Government's six-year investment plan.</p> <p>However, as noted in our evaluation, there has been less progress with managing local flood risk. Nor is there a policy in place to address the expected increase in the number of existing properties at high risk areas in the future. The introduction of Flood Re is likely to be a disincentive to the uptake of property-level flood protection measures.</p>

Table 2.1: NAP objectives and a summary of progress for the built environment theme

NAP objective	Commentary on progress
<p>Objective 2: To provide a clear local planning framework to enable all participants in the planning system to deliver sustainable new development, including infrastructure, that minimises vulnerability and provides resilience to the impacts of climate change.</p>	<p>There are eight actions for this objective of which four are completed and the other four are on-track. The actions mostly relate to the preparation of guidance, advice and tools for local planning authorities and developers to support implementation of National Planning Policy Framework policies on adapting to climate change.</p> <p>The NPPF provides a clear framework for land-use planning decisions to account for future climate change and take actions to minimise vulnerability. Formal guidance has been produced by DCLG and there has been significant effort to build capacity by the Environment Agency, as well as bodies such as the Town and Country Planning Association. NPPF policies on adaptation are increasingly being incorporated into Local Plans and as such will be directly influencing land-use planning decisions. This is particularly the case for flooding.</p> <p>However, there are concerns that the land-use planning system is not being fully effective. A high proportion of local authorities do not have legally enforceable Local Plans, which is undermining strategic planning. The lack of a regional tier of planning means that local authorities are effectively planning in isolation and not considering the cumulative build-up of risk. This is particularly an issue in parts of the country where climate change is likely to have an increasing impact in the coming decades, such as along the southern and eastern coastlines and in areas already facing high levels of water-stress. The land-use planning system is also not doing enough to improve the resilience of densely built-up areas to the increasing risk of heat stress, for example by strategically planning urban greenspaces.</p>
<p>Objective 3: Help businesses and industries in the sector to access skills, training, knowledge and tools to understand and manage climate change risks</p>	<p>There are 17 actions for this objective. They cover the work of a range of organisations to build adaptive capacity in the built environment sector. A number of research projects are being delivered by the Adaptation and Resilience in the Context of Climate Change (ARCC) network. ARCC works with researchers and decision-makers to facilitate the co-production of evidence for policymakers and practitioners working on adaptation in the built environment.</p> <p>The Environment Agency's Climate Ready service is working with the Modern Built Environment Knowledge Transfer network to develop guidance for developing business cases for adaptation projects.</p> <p>Progress is being made with increasing the capacity of the sector to understand and manage climate change risks. It is, however, not possible to quantify or independently evaluate the impact of this.</p>
<p>Objective 4: To ensure that investors and developers have the financial and appraisal decision tools needed to support and promote adaptation to climate change.</p>	<p>There are six actions for this objective. As with the previous objective, these actions focus on building adaptive capacity of the sector. This includes work by the Building Research Establishment (BRE) to review the BRE Environmental Assessment Method (BREEAM) to ensure that it promotes the need to take account of climate change adaptation.</p>

Table 2.1: NAP objectives and a summary of progress for the built environment theme

NAP objective	Commentary on progress
<p>Objective 5: To increase the resilience of homes and buildings by helping people and communities to understand what a changing climate could mean for them, and to take action to be resilient to climate risks.</p>	<p>There are 14 actions for this objective, including the development and promotion of guidance to reduce overheating risk in buildings. Measures to improve water efficiency are also listed. Most actions are complete or on-track, although two have been delayed.</p> <p>As highlighted in our evaluation, progress is being made in relation to improving the water efficiency of buildings. This relates to both existing and new development. The steady decline in average per person consumption will be in part due to improvements in water efficient buildings, as well as positive behavioural change as a result of public information campaigns by water companies. However, there is scope to increase the rate and ambition of demand reduction.</p> <p>There is less progress with the uptake of passive cooling measures in the design of new buildings and retrofitting of the existing building stock. This is explored in more detail in Chapter 4: Healthy & Resilient Communities.</p>
<p>Objective 6: To explore and build understanding of the long term implications of climate change for the location and resilience of population centres.</p>	<p>There are six actions under this objective. These refer to existing mechanisms that support long-term decision-making. These include Shoreline Management Plans and Catchment Flood Management Plans. All actions are either complete or on-track.</p> <p>It is not clear that progress is being made with this objective. Studies such as the Environment Agency's long-term investment scenarios highlight that an increasing number of homes will become at risk, and there is a limit to how much investment in flood defence is economic and justifiable. However, the implications of this are yet to be understood by the communities concerned.</p>



Chapter 3: Infrastructure

- 3.1 The importance of adapting infrastructure networks
- 3.2 Risks to infrastructure from climate change
- 3.3 Progress being made
- 3.4 Conclusions on NAP objectives and actions



Key messages

This chapter explores the essential services provided by national and local infrastructure, for example clean water, energy, communications and transportation. Infrastructure in England is exposed to a range of weather extremes including hot and cold temperatures, droughts, flooding and high winds.

Recent extreme weather events have highlighted vulnerabilities in some of the country's infrastructure. This has prompted significant activity to assess and improve infrastructure performance. However, there is limited data at the national scale to determine how much progress is being made. The investment in assets and networks that is taking place will need to continue for many years to address current vulnerabilities, whilst preparing for the more extreme conditions expected with climate change.

Overview of progress

Adaptation priorities	Is there a plan?	Are actions taking place?	Is progress being made in managing vulnerability?
1. Design and location of new infrastructure	Green	Green	Amber
2. Resilience of infrastructure services	Green	Green	Amber
(a) Energy	Green	Green	Green
(b) Public water supply	Green	Green	Amber
(c) Ports and airports	Amber	Amber	Grey
(d) Roads and rail network	Green	Green	Amber
(e) Digital infrastructure	Amber	Grey	Grey
3. Infrastructure interdependencies	Amber	Green	Amber

Notes: The criteria for Red, Amber, Green or Grey status for each of the three questions are as follows:

Is there a Plan? Green – where needed, plans or policies are in place that fully address the adaptation priority in the context of climate change.

Amber – plans or policies are in place that partially address the adaptation priority. Red – no specific policies or plans are in place

Are actions taking place? Green – all relevant NAP actions are complete or on-track, other relevant actions or commitments are being implemented. Amber – not all relevant NAP actions are on-track, partial delivery of other actions or commitments. Red – NAP actions mostly delayed or dropped, other relevant actions behind schedule.

Is progress being made in managing vulnerability? Green – trends in vulnerability are reducing or not increasing; there is high uptake of low-regret adaptation; long-term decisions are accounting for the future climate. Amber – some trends in vulnerability are increasing; scope to increase low-regret adaptation, decisions partially or inconsistently accounting for the future climate. Red – most trends in vulnerability increasing; minimal or zero uptake of low-regret adaptation; long-term decisions not taking the future climate into account. Grey – there is insufficient evidence to make a judgement.

See Chapter 1 for a full description of the approach.

Summary of progress

There is evidence that operators across most infrastructure sectors are taking steps to improve the performance of their networks and services during periods of extreme weather:

- **Energy:** Electricity transmission and distribution companies are taking a comprehensive approach to assessing risks, investing in resilience, and reporting on the progress being made.¹ The performance of major power stations in the context of the 2013/14 winter storms has been reviewed.² Three power stations had to cease generation during the severe weather experienced that winter, losing 193 GWh of production. However, this represents less than 0.3% of the electricity generated over the period and did not impact customers.
- **Water:** The 2007 floods prompted water companies to invest in resilience improvements. Further investments have been approved by Ofwat for the new Asset Management Plan period. The new system of rewards and incentives introduced by Ofwat should also encourage water and wastewater companies to achieve reliable services at least cost. A new resilience duty under the 2014 Water Act should further strengthen performance when it comes into effect from 2019, provided it is defined and performance is measured in a consistent and robust way.
- **Transport:** A wide range of activity is being taken forward in response to the independent Brown Review of transport resilience.³ The review was commissioned following the widespread disruption to the road and rail networks, and ports and airports, during the winter of 2013/14. The Government accepted all 63 recommendations and is tracking implementation across the four sectors.⁴
- **Adaptation reports:** 91 infrastructure providers, regulators and public bodies were required to produce adaptation reports in 2009 as part of the first round of reporting under the Adaptation Reporting Power (ARP). This led to some companies considering climate change risks at board-level for the first time. A second, voluntary, round of reporting is underway.
- There is also considerable investment in infrastructure upgrades and renewal. A series of sector-based National Policy Statements guide decisions on the design, location and operation of nationally-significant new infrastructure projects. The policy statements require projects to account for future climate change, and ensure no critical aspects of the infrastructure would be compromised by more radical changes to the climate than are currently anticipated.

However there remain areas where evidence of progress is lacking:

- **Ports:** Ports on the east coast of England were badly affected by the December 2013 tidal surge, the largest in the UK in sixty years. The Port of Immingham had to suspend operations for a number of days following flood damage to on-site IT servers and electricity substations. Work to assess vulnerabilities by port operators is ongoing but this appears to be focused on raising awareness of climate change; it is not clear what improvements in flood protection have been made or are planned. Having participated in the first round of ARP reporting, some ports have decided not to provide an update as part of round two.

¹ ASC (2014) *Managing climate risks to well-being and the economy*, www.theccc.org.uk/publications/

² Energy UK (2015) *A Review of Power Station Resilience over Winter 2013/14*, www.energy-uk.org.uk/publication.html?task=file.download&id=5021

³ Richard Brown (2014) for the Department for Transport *Review of the Resilience of the Transport Network to Extreme Weather Events*, www.gov.uk/government/groups/review-of-the-resilience-of-the-transport-network-to-extreme-weather-events-expert-panel

⁴ DfT (2014) *Government Response to the Transport Resilience Review*, www.gov.uk/government/publications/transport-resilience-review-governments-response

Key messages

- **Airports:** Passengers at Gatwick Airport suffered significant disruption on Christmas Eve of 2013. Flood alerts were missed by duty staff, and flood water damaged basement IT and power facilities. The similarity between the Immingham and Gatwick incidents led the Brown Review to conclude that poor siting of critical power and IT equipment may be a common vulnerability across many sectors that should be addressed as a matter of urgency.
- **Digital infrastructure:** Adaptation plans are at an early stage in the digital infrastructure sector (encompassing fixed line and mobile telephony, and internet and data service providers). These services should be reasonably robust, with companies competing on the basis of service reliability.⁵ The first ARP reports from the sector are due this year. It is hoped these will allow any specific vulnerabilities, and the actions being taken, to be better understood.
- **Systemic risks:** There is evidence that new infrastructure projects account for the primary climate risks, such as heatwaves, river flooding and sea level rise. There is less evidence that coastal erosion, water scarcity, shrink/swell subsidence, groundwater and surface water flooding risks are considered. The potential for systemic risk increasing as a result of individual infrastructure decisions being taken in isolation does not appear to be being assessed.

Recommendations for further progress

- **RECOMMENDATION 9:** In time for the ASC's next progress report in June 2017, the Department for Communities and Local Government should develop an approach to assess whether systemic risk is increasing or reducing as a result of individual decisions on the location of new national infrastructure assets. This should inform a decision on whether there is a need for an overarching National Policy Statement to guide decisions on the design and location of new assets.
- **RECOMMENDATION 10:** The Cabinet Office should work with all infrastructure sectors as part of the next round of sector resilience plans in 2015 to develop consistent incident reporting, together with indicators of network resilience and performance, to allow improvements to be measured over time. The results should be presented by operators as part of their reports under the third round of the ARP. Reporting as part of the third round of the ARP should be made mandatory.
- **RECOMMENDATION 11:** The Cabinet Office should confirm that the services provided by all critical national infrastructure (CNI) are now resilient to a 1-in-200 year flood event. The Cabinet Office should agree, for a wider range of climate risks, sector resilience standards that are in the national interest and see that they are implemented. This process should inform the 2016 round of sector resilience planning.
- **RECOMMENDATION 12:** Information on asset and network resilience should be shared between operators of interdependent assets, and with Local Resilience Forums. The Cabinet Office should facilitate the piloting of secure information sharing arrangements within a year of this report's publication. Based on the results, the Cabinet Office should consider introducing in this Parliament a legal duty to co-operate and share such information.

⁵ AEA (2010) for Defra *Adapting the ICT Sector to the Impacts of Climate Change – Final Report*, www.gov.uk/government/uploads/system/uploads/attachment_data/file/183486/infrastructure-aea-full.pdf

RECOMMENDATION 13: The UK Regulators Network should ensure that proportionate and cost-effective approaches to increasing resilience and reducing climate change risks are in place for the economically-regulated sectors. A cross-sector review of reward and penalty regimes should be conducted in time for the ASC's next progress report in 2017, to ensure there are sufficient incentives in place for operators to manage severe weather incidents effectively and preserve services where possible.

Vision: "An infrastructure network that is resilient to today's natural hazards and prepared for the future changing climate."

HM Government, 2013 National Adaptation Programme

As noted in Chapter 1, the NAP objectives tend to describe processes rather than outcomes and do not always state goals against which progress can be measured. Even where the stated objectives are being achieved, vulnerability to climate change impacts may be increasing.

To enable a robust assessment, we have identified a set of adaptation priorities for each of the NAP themes. The progress being made in respect of each of the adaptation priorities is reviewed in Section 3.3.

Figure 3.1 summarises the climate hazards, contextual factors and adaptation priorities that are relevant to infrastructure, together with a summary of the actions listed in the National Adaptation Programme.

3.1 The importance of adapting infrastructure networks

England's physical infrastructure, composed of the facilities and systems necessary for the functioning of the country, is a priority for adaptation. Infrastructure systems are long-lived, often sensitive to severe weather, and their failure can have knock-on impacts on other networks and assets. Resilient infrastructure networks and services are a key attribute of economic competitiveness. Acting now to improve resilience makes economic sense, especially in the context of climate change.

- The resilience of infrastructure is routinely tested by extreme weather. Natural hazards such as storms, flooding, heavy snow, and droughts, already account for 10% to 35% of all delays or service interruptions to electricity, road and rail customers per year.⁶ Flooding in particular can have long-lasting consequences for infrastructure networks and cause widespread disruption. Although there is uncertainty about the exact changes that can be expected, more severe and frequent extreme weather and flooding is projected with climate change.
- Most infrastructure assets are long-lived and costly to retrofit once they are built. Infrastructure planning and design should therefore account for the projected changes and uncertainties in the future climate over the rest of the century and beyond for the longest-lived assets. Infrastructure can be built from the outset in light of these projections, or designed in such a way to allow it to be upgraded cost-effectively as the climate changes (termed a 'managed adaptive' approach).

⁶ ASC (2014).

3.2 Risks to infrastructure from climate change

The UK Climate Change Risk Assessment (CCRA) points towards increasing hazards to infrastructure arising from high temperatures, flooding, and coastal erosion in the coming decades.⁷

- The majority of infrastructure assets in areas exposed to flooding from rivers or the sea are located in lower risk parts of the floodplain. This is where the likelihood of flooding is less than a 1-in-100 chance annually. Most assets that are in higher risk locations have at least some protection. However, with climate change the number of current electricity, road and rail, and public water supply assets in areas at a high likelihood of flooding (1-in-30 annual chance or greater) are projected to increase by between 33% and 120% by the 2050s.⁸ In the winter of 2013/14 a significant cause of disruption to the railway network was from heavy rain outside of recognised flood risk areas. Severe downpours caused landslips in cuttings and on embankments, many built over a century ago to outdated engineering standards.
- The short lengths of the rail and major road networks that are directly exposed to coastal erosion are protected by sea walls. However, coastal defences can fail as was seen at Dawlish during the 2013/14 winter storms. Projections suggest that the length of the rail network exposed to coastal erosion will increase from 11 kilometres today to 62 kilometres by the end of the century.⁹
- The exposure of assets to high temperatures will increase. The chance of summer mean temperatures as hot as seen during the 2003 heatwave has already very likely doubled as a result of historic greenhouse gas emissions.¹⁰ However, much of the mechanical and electrical equipment used in the UK is designed to international standards. This means they can be expected to cope as temperatures increase further.

Whilst temperatures in general are expected to increase, there will remain a chance of cold snaps and heavy snow throughout the century. There is some evidence that the chance of severe cold weather will be higher in the next few decades before the overall warming trend begins to dominate.¹¹ Temperatures in the UK in the summer have been increasing more rapidly than in winter.¹² Both of these factors suggest infrastructure operators should plan on the basis of a greater range and variability of temperature being experienced.

Infrastructure assets could also become more exposed to subsidence, water scarcity, high winds, humidity, fog, storms and lightning, but there are larger uncertainties in projecting future changes in these hazards. The National Adaptation Programme (NAP) does not address these risks.¹³

The infrastructure chapter within the NAP only considers the key risks highlighted within the first Climate Change Risk Assessment. These primarily relate to flooding and water scarcity, and their impacts on the water, transport and energy sectors. However, a previous government report on infrastructure resilience also highlighted information and communication technologies (ICT, or digital infrastructure) as a key sector, including risks in terms of other networks' reliance on ICT performance.¹⁴

⁷ HM Government (2012) *UK Climate Change Risk Assessment: Government Report*, www.gov.uk/government/publications/uk-climate-change-risk-assessment-government-report

⁸ *Ibid.* See Figure 3.5.

⁹ *Ibid.* See Figure 3.6.

¹⁰ Met Office (2014) *Too hot, too cold, too wet, too dry: drivers and impacts of seasonal weather in the UK*, www.metoffice.gov.uk/media/pdf/4/8/Drivers_and_impacts_of_seasonal_weather_in_the_UK.pdf

¹¹ Baek-min Kim et al. (2014) Weakening of the stratospheric polar vortex by Arctic sea-ice loss. *Nature Communications* 5, Article number 4646.

¹² Met Office (2014).

¹³ HM Government (2013) *National Adaptation Programme, making the country resilient to a changing climate*, www.gov.uk/government/publications/adapting-to-climate-change-national-adaptation-programme

¹⁴ HM Government (2011) *Climate Resilient Infrastructure: Preparing for a Changing Climate*, www.gov.uk/government/uploads/system/uploads/attachment_data/file/69269/climate-resilient-infrastructure-full.pdf

The National Adaptation Programme sets four objectives for the infrastructure theme.

These objectives were identified following extensive consultation with a wide range of stakeholders with expertise in climate change and infrastructure.

- **Objective 7.** To ensure infrastructure is located, planned, designed and maintained to be resilient to climate change, including increasingly extreme weather events.
- **Objective 8.** To develop regulatory frameworks to support and promote a resilient and adaptive infrastructure sector.
- **Objective 9.** To better understand the particular vulnerabilities facing local infrastructure from extreme weather and long term climate change to determine actions to address the risks.
- **Objective 10.** To develop understanding and promote expertise in managing interconnected and interdependent services, to minimise the risks of cascade failures which could be exacerbated by climate change and identify how systems thinking can support this objective.

The NAP objectives describe important high-level principles and processes for adapting infrastructure. We have reviewed progress by the actions in the NAP against each objective in Section 3.4 below.

As noted in Chapter 1, the NAP objectives tend to describe processes rather than outcomes and do not always 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, we have identified a set of adaptation priorities for each of the NAP themes. The progress being made in respect of each of these adaptation priorities is reviewed in Section 3.3.




Figure 3.1 summarises the climate hazards, contextual factors and adaptation priorities that are relevant to the infrastructure theme, together with the relevant actions listed in the NAP.

Figure 3.1: Climate hazards, contextual factors and adaptation priorities for the infrastructure theme			
Climate hazards	Contextual factors	Adaptation priorities	Relevant NAP actions
Heavier rainfall	Population growth	Design and location of new infrastructure	<ul style="list-style-type: none"> • New infrastructure to take account of climate change in line with National Policy Statements • Government to factor climate change into new policies and strategies
Sea level rise & flooding	Urbanisation		
Reduced water levels/flows	Higher customer expectations	Resilience of infrastructure services:	<ul style="list-style-type: none"> • Operators to implement the actions in their reports under the Adaptation Reporting Power • The Government to promote climate resilience through regulatory frameworks • EA Climate Ready to support the LGA's Climate Local initiative to improve the resilience of local transport infrastructure • TfL to carry out extensive flood risk review for the London Underground network • DfT, UK RLG, ADEPT and Climate UK to work together to build capacity and knowledge on local transport resilience
Higher air & water temperatures	Economic growth	Energy	
Subsidence/slope instability	Land use change	Public water supply	
	Technological change	Ports and airports	
High winds	Increase in trade & mobility	Road and rail	<ul style="list-style-type: none"> • Joint EA/Energy UK project on dependency of the energy sector on water resources • IUK and IRTC to enhance systems thinking around interdependencies between networks • EA Climate Ready guided activity including Infrastructure Operators Adaptation Forum, knowledge sharing
Humidity, lightning, fog	Increasing system utilisation and efficiency (eg. 'just in time')	Digital infrastructure	
Cold snaps, ice, snow		Infrastructure interdependencies	

3.3 Progress being made

This section evaluates the extent to which the actions and policies in the NAP and elsewhere are addressing the identified climate risks, following the method described in Chapter 1. Further details and the underlying evidence supporting the analysis for each of these factors can be found in an annex to this report available on the CCC's website.¹⁵

3.3.1. Design and location of new infrastructure

Is there a plan?		The series of sector-based National Policy Statements (NPSs) emphasise climate change risks and projections when considering the location and design of new infrastructure
Are actions taking place?		New infrastructure projects appear to be taking account of the primary climate hazards in line with the National Policy Statements. A new National Networks NPS (for road and rail) was published in December 2014.
Is progress being made in managing vulnerability?		There is no overarching National Policy Statement to guide the location of important national infrastructure. There may be systemic risk arising from individual infrastructure decisions being taken in isolation, such as in areas of flood risk or water stress.

The series of sector-based National Policy Statements require climate change projections to be taken in to account when developing new infrastructure projects. In a review of recent nationally-significant infrastructure projects, the ASC found that flood risk in particular is being considered. Less account appears to be taken of other climate hazards.

Twelve sector-level National Policy Statements have been proposed, with ten published since 2011. These cover the energy, transport, water and waste sectors. Whilst an Airports NPS and a Water Supply NPS have been proposed, the Planning Inspectorate is not aware of any plans by the Department for Transport and Defra, respectively, to produce these.¹⁶

Between 2010 and March 2014 there were 40 planning applications for nationally-significant infrastructure projects (NSIPs). Last year, the ASC commissioned a review of the 14 applications where the Planning Inspectorate had made a decision to approve or reject the application (13 approved, one rejected). Box 3.1 summarises how a selection of these projects have taken account of climate change, along with HS2, which will be subject to a separate process of Parliamentary consent.

Flood risk and sea level rise were the primary climate hazards assessed by NSIPs.¹⁷ Less account appears to be taken of other climate hazards, where the magnitude of impact is less certain but still could be significant. Such hazards include water scarcity, subsidence, windstorm, fog, lightning and groundwater flooding.

There is no over-arching National Policy Statement to guide the strategic location of important infrastructure assets. There is in effect a 'first-come-first-served' approach to land use in England. As a result, strategically important sites may be being used for less critical needs.

Planning decisions on new nationally-significant infrastructure projects are made individually. Whilst National Policy Statements require the Planning Inspectorate to consider interdependencies and cumulative adverse impacts there is no evidence that this takes place in practice. The Planning

¹⁵ See: <http://www.theccc.org.uk/publications/>

¹⁶ See: <http://infrastructure.planningportal.gov.uk/legislation-and-advice/national-policy-statements/>

¹⁷ HR Wallingford (2014) for the ASC *An assessment of applications for Nationally Important infrastructure*, <http://www.theccc.org.uk/wp-content/uploads/2014/07/Planning-MCR5195-RT006-R02-00.pdf>

Inspectorate considers applications on their individual merits, and is reliant on others, in particular the Environment Agency, to give advice on flooding and sea level rise. As a result, individual decisions may be increasing systemic risk, for example by locating more and more important assets in areas prone to a tidal surge.

RECOMMENDATION 9: In time for the ASC's next progress report in June 2017, the Department for Communities and Local Government should develop an approach to assess whether systemic risk is increasing or reducing as a result of individual decisions on the location of new national infrastructure assets. This should inform a decision on whether there is a need for an overarching National Policy Statement to guide decisions on the design and location of new assets.

Box 3.1: Examples of how large infrastructure projects have accounted for climate hazards

High Speed 2 rail link

- The Environmental Statement for the High Speed 2 rail scheme includes a 'climate risk and resilience assessment' that applied the 2009 UK Climate Projections for a wide range of climate hazards over a 120 year time period. This has identified two high risks: flooding of track, tunnels and cuttings, and the overheating of tunnels.
- Adaptation measures have been identified in the design of the scheme to mitigate these risks. These include protecting against a 1-in-1,000 year flood event, designing drainage to accommodate 1-in-100 year rainfall events (including a 30% allowance for climate change), and provision of adequate space in tunnels to allow for additional cooling and ventilation if required in the future.

North Blythe Biomass Power Station

- Climate projections to 2070 have been considered, including sea level rise and 1-in-200 and 1-in-1,000 year flood events. Part of the site lies in Flood Zone 3.¹⁸ This risk is being managed by making sure biomass can continue to be delivered during any flood event and that the cooling water intake to the pump house is located in a lower flood risk part of the site.
- Higher temperatures, and increased risk of drought, were not mentioned in the Planning Inspectorate's assessment of the application.

Hinkley Point C Nuclear Power Station

- The increased risk of flooding up to 2100 has been considered. Initial concerns raised by the Environment Agency have been addressed. The potential for the site to increase flood risk elsewhere has been considered and mitigation measures proposed.
- The risk of coastal erosion was not mentioned in the Planning Inspectorate's assessment of the application.

East Northamptonshire Hazardous Waste Facility

- Flood risk has been considered, including the effects of climate change. A surface water management plan was produced including measures to address the risks identified. A 1-in-100 year drainage standard for storm water was incorporated into the design.

Sources: HR Wallingford (2014) for the ASC. HS2 (2013). *London-West Midlands Environmental Statement, Volume 3 - Route-wide effects*. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/259488/Volume_3_Route-wide_effects.pdf

Note: HS2 is subject to its own Act of Parliament and is not formally a NSIP.

¹⁸ Where land has a 1-in-100 or greater annual probability of river flooding, or a 1-in-200 or greater annual probability of flooding from the sea, ignoring the presence of flood defences.

Actions relating to new infrastructure in the National Adaptation Programme focus on embedding climate change risks within key policy documents such as the Energy Security Strategy, operator business plans, and the series of National Policy Statements.

Whilst actions are generally on-track, Environment Agency guidance due in 2013 on building climate resilience into infrastructure planning has not yet been published. This guidance is intended for the Planning Inspectorate and applicants, and will now be published later this year. Some new capacity-building initiatives have been completed.

For example, Defra's Infrastructure & Built Environment Design Competition funded five projects, one of which related to infrastructure.¹⁹ This tested smart sensors that monitor silt and water levels in gullies. Such live data can be used by highways authorities to prioritise gully maintenance.

3.3.2. Resilience of infrastructure services

Is there a plan?	 Green	Sector resilience plans were drawn up following the 2007 flooding. Resilience reviews for transport networks, and power stations, were conducted after the 2013/14 winter storms. A Cabinet Office 'annual resilience review' was also announced though its findings have not been reported.
Are actions taking place?	 Green	Action is evident in most areas, most notably in the regulated infrastructure sectors that have routine reporting requirements. Evidence that risk assessments have been performed, and vulnerabilities addressed, is weaker for commercial operators such as ports and airports.
Is progress being made in managing vulnerability?	 Amber	Even where evidence of action is available, it is usually not possible to establish how much progress in addressing vulnerabilities has been achieved. Climate change will to a degree counteract the actions being taken by all sectors, requiring further investment to be made.

There is no published account of what has been achieved by efforts in recent years to improve the resilience of infrastructure systems. Sectors do not report on the resilience of their assets, networks and services. Few systematically describe the disruption that has been caused by severe weather, and the actions that have been taken as a result. The Pitt Review suggested that as a minimum, critical infrastructure assets should be protected to a 1-in-200 year standard against flooding.²⁰ It is not clear whether this is now the case.

The Cabinet Office Critical Infrastructure Resilience Programme was established following the widespread flooding 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 to develop sector resilience plans. These focused initially on the resilience of the UK's critical national infrastructure to flooding. Sector resilience plans have been updated each year and broadened to consider the range of weather and non-weather related hazards set out in the National Risk Assessment. A public summary of the plans is published each year.²¹ There has been no public account of the findings of the "annual review in to the resilience of our nation", announced after the 2013/14 winter storms.²² Two cycles of the review are now complete, and is discussed further in Section 3.3.3.

¹⁹ Defra (2014) *Infrastructure & Built Environment Design Competition (SBRI)* - CA0517.

²⁰ Sir Michael Pitt (2008) *Learning lessons from the 2007 floods*, http://webarchive.nationalarchives.gov.uk/20100807034701/http://archive.cabinetoffice.gov.uk/pittreview/the-pittreview/final_report.html

²¹ See: www.gov.uk/government/collections/sector-resilience-plans

²² See: www.gov.uk/government/news/first-meeting-of-new-cabinet-committee-on-flooding

Across all sectors it is difficult to assess the true vulnerability to weather-related hazards. To do so requires consideration of the resilience of systems as well as of the assets that combine to create systems. Networks may be resilient even if individual assets fail, if services can be provided by alternative means. Recognising this, 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%)”*.²³ 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.

Action to improve resilience is more apparent within the economically-regulated sectors such as power, water, road and rail. The Adaptation Reporting Power 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.

RECOMMENDATION 10: The Cabinet Office should work with all infrastructure sectors as part of the next round of sector resilience plans in 2015 to develop consistent incident reporting, together with indicators of network resilience and performance, to allow improvements to be measured over time. The results should be presented by operators as part of their reports under the third round of the ARP. Reporting as part of the third round of the ARP should be made mandatory.

Resilience activity to date has focused on where the evidence of climate change impacts is strongest: sea level rise, flooding and heavy rain, and increasing temperatures. Other impacts are less certain but could be significant. These include subsidence and slope instability, cold snaps, high winds, fog, lightning and humidity.




Average and peak temperatures across England are expected to rise, and the chance of severe cold winters should diminish over the century. Climate projections of wind strength and direction are highly uncertain, providing no clear signal of change. There is some evidence that lightning strikes will increase, with humidity, and that fog in southern England will increase whilst becoming less frequent in the north.²⁴

There are no specific actions within the NAP to address the risk of shrink/swell subsidence, cold snaps, higher winds, fog and lightning. In the absence of clear evidence about the effect of climate change, adaptation is being driven by current climate risks.

²³ Cabinet Office (2011) *Keeping the Country Running: Natural Hazards and Infrastructure*, www.gov.uk/government/publications/keeping-the-country-running-natural-hazards-and-infrastructure

²⁴ Met Office (2014).

3.3.2a. Energy generation, transmission and distribution

Is there a plan?		Ofgem's RIIO ²⁵ performance standard for gas and electricity companies incentivises investment in safe and reliable services.
Are actions taking place?		The electricity transmission and distribution companies have agreed business plans with Ofgem to address river and coastal flooding risks by the early 2020s. The cross-industry ETR138 standard for network resilience to flooding is being reviewed. More deployable flood barriers were purchased by National Grid after the 2013/14 winter storms. The Environment Agency has assessed water demands for electricity generation through to the 2050s.
Is progress being made in managing vulnerability?		Electricity transmission and distribution companies are transparently taking steps to improve flood protection levels for critical substations over the coming decade. The national coverage and resilience of the transmission grid means that even if individual power stations are disrupted, customers can continue to be supplied from elsewhere. The gas transmission and distribution networks are less exposed to climate change risks.

Electricity networks by their nature are exposed to range of climate hazards. Most weather-related customer outages are currently due to high winds affecting distribution network lines and substations. Lightning, snow and ice, and flooding, have also caused power cuts in recent years.

Five large power stations (6% by number of those over 1 GW), 40 electricity transmission substations (9% of the total), and 57 major electricity distribution substations (1% of those with a voltage of between 6.6 to 132 kV), are located in areas at a high likelihood of flooding²⁶ after accounting for the presence of flood defences.²⁷

Three power stations had to be shut down during the severe weather in the winter of 2013/14, losing 193GWh of production. However this represents less than 0.3% of the power generated over the period and did not lead to any loss of power to customers.²⁸

Power cuts caused by power station outages are rare. 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.

Gas transmission networks are less exposed to climate hazards and are inherently more reliable. However, any failures of the gas transmission network can result in more serious consequences due to the risk of explosions. As a result the Health and Safety Executive places strong emphasis upon the transmission operators, and National Grid Gas, to maintain a safe system.²⁹

The relative exposure of the electricity network is recognised and investment is taking place for example to improve levels of flood protection for major substations. However, climate change will increase the hazard to power sector assets.

The number of large power stations in areas of high flood risk is expected to more than double, from five now to 11 by the 2050s, as a result of climate change. The number of electricity transmission and distribution substations in areas at a high likelihood of flooding is expected to increase by 35% and 77% respectively.³⁰ However, over the same period some power stations will be decommissioned and others will be brought in to operation.

²⁵ RIIO stands for Revenue = Incentives + Innovation + Outputs, and means network companies' income is dependent on their performance.

²⁶ At a 1-in-30 annual chance of flooding or greater.

²⁷ ASC (2014).

²⁸ Energy UK (2015).

²⁹ Ofgem (2011) *Adaptation to Climate Change: Report to Defra*.

³⁰ ASC (2014).

Electricity substations serving one million customers are due to benefit from flood protection measures by the end of the decade. However during the 2020s, climate change is expected to mean substations serving around a half a million customers will fall in to the high flood risk category. Unless further mitigating measures are put in place climate change will diminish the gains being made. In the 2020s there are expected to be 150,000 customers reliant on substations in areas at a high likelihood of flooding.³¹

Energy UK considers that current levels of flood and coastal protection for power stations are 'adequate'.³² This is because there were no power outages caused by fluvial, surface water or coastal flooding in the winter of 2013/14. However, it is possible that a different combination of events, or a slightly higher tidal surge than in December 2013, could have much more severe consequences.

Electricity generation is also reliant on abundant water for cooling. As well as coastal and tidal waters, power stations are heavy users of freshwater. Abstraction and consumption of freshwater for power generation should fall in the coming decades, but then rise again in the longer-term under most energy-mix scenarios. A reliance on coal-fired generation using carbon capture and storage would place the greatest additional demands on sources of freshwater.³³

In England and Wales, the electricity sector is responsible for approximately half of all water abstractions and 40% of non-tidal freshwater abstractions. In the period to 2030, significant reductions in both the carbon and water intensity of power generation are expected. Scenarios involving high levels of energy efficiency, renewables, and nuclear, show the largest, sustained reductions in freshwater abstraction and consumption.³⁴

Carbon capture and storage (CCS) is likely to be a crucial part of the least-cost path to decarbonisation in the UK, and globally. In scenarios with high levels of carbon capture and storage, the expected falls in freshwater abstraction and consumption levels by 2030 are followed by rapid increases. By the 2050s, freshwater consumption by power stations could be double current levels under a high CCS scenario. Coal-fired power stations using CCS are particularly water-intensive. Clustering of CCS plants would intensify local water demands.³⁵

As well as the availability of water, its temperature is an important consideration. Warmer water in rivers, estuaries and the sea will reduce the efficiency of water-cooled thermoelectric plant. High water temperatures in the natural environment, as well as water scarcity, may restrict plant being operated during periods of very low flows. Hybrid cooling systems are available, whereby air cooling is used when using freshwater will be less effective. However, air cooling technologies are more costly to install and more energy intensive to operate.

Hydraulic fracturing (fracking) to release shale gas is another water-intensive energy technology that could grow in use in the coming years. Operators wishing to abstract water will need to apply for a licence under the normal arrangements. The Environment Agency has stated that it would not issue a licence unless they are satisfied that the activity would neither damage the environment nor interfere with the abstraction rights of other water users.³⁶ Under the 2015 Infrastructure Act, the Committee on Climate Change has a new duty to report on onshore petroleum exploitation and its impact on carbon budgets. The CCC will report to the Energy Secretary in March 2016.

³¹ *Ibid.*

³² Energy UK (2015).

³³ Byers et al. (2014) Electricity generation and cooling water use: UK pathways to 2050. *Global Environmental Change* 25: 16-30




³⁴ *Ibid.* Assumes any new nuclear power generation is located on the coast.

³⁵ *Ibid.*

³⁶ In evidence to Environmental Audit Committee inquiry on fracking, 14 January 2015.

In line with an action with the NAP, the Environment Agency has assessed water demand for electricity generation through to 2050. A public summary of the findings was published in 2013.³⁷ Energy-mix scenarios have also been factored in to the Environment Agency's overall assessment of future water scarcity.³⁸

3.3.2b. Public water supply

Is there a plan?		Water resources management plans, and agreed business plans, require water companies to invest in the security of water supplies to their customers. Both take account of climate projections.
Are actions taking place?		Water companies have been encouraged by the regulator, Ofwat, to invest in improving the resilience of assets and systems to natural hazards, especially after the 2007 floods. The 2014 Water Act introduced a new primary duty on Ministers, and Ofwat, to secure resilience in water and wastewater services to customers. This will apply from 2019. The new outcomes-based performance framework and the emphasis on 'totex' in the next Asset Management Plan period should give operators the flexibility to deliver resilient services at least cost.
Is progress being made in managing vulnerability?		Whilst there is significant investment taking place to increase the resilience of the public water supply it is not possible to tell whether, over time, services are becoming more or less reliable. Customer outages caused by severe weather are not recorded as a separate category and there are as yet no agreed standards or definitions for what resilience means.

Water abstraction sites, treatment works and pumping stations by their nature need to be located near to watercourses. This means a large proportion of water company assets are in areas at risk of flooding. Significant failures have occurred, most notably at the Mythe water treatment works during the 2007 floods. However, the industry maintains that outages caused by severe weather are so rare as to not warrant recording as a specific category, and investment in measures to improve resilience is continuing. This includes connecting customers to more than one source of water, and also to improve response and recovery procedures.

- 120 clean water treatment sites in England are in areas with a high likelihood of flooding. The number is expected to increase by 50%, to 180, by the 2050s with climate change.³⁹
- In advance of the 2010 - 2015 Asset Management Plan period (AMP5), Ofwat required companies to review the risk of flooding to their critical assets and to identify where further investment is necessary. This led to around £410 million in agreed investment to improve the resilience of assets and systems to flooding and other natural hazards.

³⁷ See: www.gov.uk/government/publications/water-use-and-electricity-generation

³⁸ Environment Agency (2013) *Current and future water availability – addendum: a refresh of the Case for Change analysis*, http://webarchive.nationalarchives.gov.uk/20140328084622/http://cdn.environment-agency.gov.uk/LIT_8951_b4d670.pdf

³⁹ ASC (2014).

- Companies were instructed to again consider the resilience of assets to major risks in their business plans for 2015 - 2020 (AMP6). Water company business plans for AMP6 included £660 million for network resilience, including £60 million for wastewater services. This suggests an increase in resilience activity in comparison with the last period.⁴⁰ However, the lack of an agreed 'resilience' investment category makes period-to-period comparisons difficult. A single project in the Severn Trent area accounts for a significant proportion, around half, of the forthcoming investment in resilience by water companies.⁴¹
- Frequent changes in Ofwat's reporting requirements for disruptions also makes it difficult to identify trends in customer outages. There is no specific reporting category for outages caused by severe weather.

An example of water company investment in resilience is the connection of customers to more than one source of water, to avoid single points of failure. Anglian Water have provided data showing the number of customers served by a single supply of water will have more than halved by the end of the AMP6 period, when compared to the number in 2005. It would be useful for similar data to be reported on a consistent basis by all water companies.

When Severn Trent's water treatment works at Mythe flooded in 2007, water supplies were cut to 140,000 properties (350,000 people). Only 20,000 of these could be supplied with running water from another source. The remainder had to rely on bottled water, tankers and bowsers. It took fifteen days to restore safe drinking water to all affected properties. Prior to the flooding Severn Trent Water regarded the site as adequately protected.⁴²

Severn Trent Water has supplied data that show the loss of water supplies during severe weather is a rare event. They have identified less than ten incidents per year of water being cut-off due to weather events, out of around 600 supply losses per year altogether. For this reason Severn Trent, and other water companies, do not routinely record severe weather as a specific and separate root cause of supply disruption.

In February 2014 the Kenley water treatment works near Croydon flooded. This threatened the supply of drinking water to 46,000 properties. It took the combined efforts of the Environment Agency, the British Army, Croydon Council and the emergency services to avoid supplies being disrupted. National Grid provided temporary flood barriers.⁴³ It is concerning that during a period of sustained flooding, affecting several areas of England, emergency responders had to be diverted to protect drinking water facilities. Six years after the Pitt Review made a specific recommendation,⁴⁴ drinking water supplies should by now be resilient to a worst case flood event without having to rely on the resources and goodwill of others.

As well as allowing funding for resilience projects, important and positive changes have been made by Ofwat to the regulatory framework for the AMP6 period. The shift towards measuring performance in terms of outcomes, and the end of the previous bias towards 'capex' expenditure, should give water companies the flexibility to improve resilience at least cost to customers. The new resilience duty, to come in to force in time for the next AMP period, should drive performance further.

⁴⁰ The £660 million figure reflects proposals included by water companies in their final business plans for the 2014 periodic review (PR14) rather than costs allowed for in price limits set by Ofwat. During the previous periodic review in 2009 water companies proposed £560 million investment in resilience in their final business plans. Around £410 million of this proposed investment was agreed to by Ofwat in final determinations. Due to a change in methodology for PR14, Ofwat has not disaggregated the costs for resilience in its final determinations. However, comparing the amount of investment proposed in final business plans, adjusted for inflation, would suggest investment in resilience has increased.

⁴¹ See: www.stwater.co.uk/my-supplies/live-updates/investing-in-local-improvements/birmingham-resilience-project/

⁴² Severn Trent Water (2007) *The impact of the July Floods on the Water Infrastructure and Customer Service*, www.stwater.co.uk/upload/pdf/The_Final_Gloucester_2007_Report.pdf

⁴³ See: www.waterplc.com/pages/news/current-works/kenley-flooding/

⁴⁴ See recommendation 52.

Ofwat has changed the system of penalties and rewards so that water companies are encouraged to deliver important outcomes to customers for least cost. Previously Ofwat tried to make sure certain agreed projects and outputs were delivered, even if companies found better and cheaper ways to meet customers' needs.

The new regulatory system also removes the bias towards investing in big capital projects, treating operational (ongoing or 'opex') and capital investment ('capex') on a more equal basis. This should encourage more innovative thinking by water companies, and solutions that deliver a range of outcomes and benefits at least cost.

For example, previously if a sewer was under capacity and causing flooding a water company might favour a capital-intensive solution such as installing bigger pipes. Now water companies have greater flexibility to, for example, introduce sustainable drainage systems (SuDS) to slow down and reduce the amount of rainwater entering the sewer network. SuDS involving natural features, such as ponds and swales, also improve water and air quality, and counter the urban heat island effect. As a result water company investment in SuDS and other, less capital intensive, solutions should increase.

If there is a shift in approaches it may be difficult to detect. The new focus on outcomes means there is less focus by Ofwat on how they are being achieved. Water companies may deliver agreed outcomes but it won't be clear how, in the absence of consistent metrics and datasets at the national level. Where certain approaches, such as SuDS, deliver a range of co-benefits for the water sector and beyond, it is important from an adaptation to perspective to know how outcomes are being achieved; SuDS and piped solutions may be designed to achieve the same outcome now, but SuDS can be more readily adapted as the climate changes. Only four wastewater companies (~20%) have made a performance commitment that specifically mentions the use of SuDS to address the risk of sewer flooding.

The 2014 Water Act introduced two significant new requirements on the water industry. In advance of the next AMP period the industry needs to decide how it will fulfil its new resilience duty (see Box 3.2). Water companies already plan for droughts as part of their Business Plans, and the Water Act includes an additional power for the Defra Secretary of State to direct water companies to plan for droughts of a specified magnitude.

Box 3.2: The new primary duty on the Secretary of State and Ofwat to secure water industry resilience

Ofwat had three primary duties in legislation prior to the 2014 Water Act. The Act added a fourth primary duty on Ofwat with the objectives:

- (a) to secure the long-term resilience of water undertakers' supply systems and sewerage undertakers' sewerage systems as regards environmental pressures, population growth and changes in consumer behaviour; and
- (b) to secure that undertakers take steps for the purpose of enabling them to meet, in the long term, the need for the supply of water and the provision of sewerage services to consumers,

including by promoting:

- (i) appropriate long-term planning and investment by relevant undertakers; and
- (ii) the taking by them of a range of measures to manage water resources in sustainable ways, and to increase efficiency in the use of water and reduce demand for water so as to reduce pressure on water resources.

This duty also applies to the Defra Secretary of State.

Ofwat has established an independent working group to help define how the industry will fulfil the new duty.

Source: 2014 Water Act, Section 22.

Water industry resilience depends on being able to meet demand for water even in times of scarcity and drought. Some climate change projections suggest a gap between demand and supply (a supply-demand deficit) for England as a whole could open up as early as the 2020s without additional action. There is significant scope to increase efforts to reduce the demand for water. This could form a potential win-win. It would postpone the need for major capital investment in new sources of supply, whilst reducing customer bills for the increasing number of households whose use of water is metered.

The Climate Change Risk Assessment identified a high level of uncertainty associated with the risks to future water availability, but with some risk of a deficit in most regions in the near-term under mid-range climate change projections. Whilst precipitation could increase or decrease, temperature will increase on average resulting in increased evapotranspiration. The CCRA indicated that increasing aridity, and population growth, will put increasing pressure on the demand for water. There are large regional variations, with the largest deficits projected in the Thames and Humber regions.

Water companies are required to prepare Water Resources Management Plans (WRMPs) every five years. These set out how water companies plan to balance water supply and demand over the next 25 years, taking into account the effects of climate change as well as other factors such as population growth. In the latest round of WRMPs, water companies have put forward plans to deal with projected deficits in their regions over the period to 2040. Collectively, these would increase supplies by around 870 megalitres per day (MI/day), reduce demand by 300 MI/day, and reduce leakage by 230 MI/day.⁴⁵ These measures are sufficient to deal with supply-demand deficits at the national scale under low to medium climate change projections, though not the high-end estimate of the potential deficit.




⁴⁵ Environment Agency, unpublished.

WRMPs suggest water companies will be focusing on demand-side measures over the next decade. 90% of the 300 Ml/day reduction in demand proposed by 2040 will have been achieved by 2025 according to current plans. Supply-side measures begin to dominate in WRMPs from 2025 onwards, accounting for nearly all of the proposals to deal with future deficits from the mid-2020s. This may be because water companies are not confident about what might be achievable on the demand side once they get beyond familiar measures. Gains from supply side measures are more predictable. However, in the face of large uncertainties in future water availability, a continuing focus on demand management through the 2020s and beyond will represent a low-regret approach.

Implementing the demand-side measures in WRMPs would help to lower per capita consumption from around 140 l/day currently to around 135 l/day by 2040. This is only marginally below the level that will be reached by 2020 if performance commitments for AMP6 are delivered. Previous analysis by the ASC suggests the uptake of cost-effective water efficiency measures, such as low-flow showers and dual-flush WCs, could reduce consumption per person to 115 l/day.⁴⁶ Empirical trials suggest that water efficiency measures can reduce household consumption by an average 20 to 40 litres per day, which roughly equates to 9 to 17 l/day per person.⁴⁷ This suggests greater ambition on demand management is readily achievable.

Reductions in water use could save money for the growing proportion of households on water meters (around half of all households are now on meters). A 42 l/day reduction in household consumption would save metered households an estimated £78 per year (21%). A more modest 25 l/day reduction would save an estimated £45 per year (13%).⁴⁸

3.3.2c. Ports and airports

Is there a plan?		The operational performance of ports and airports is not regulated. The Government relies on commercial incentives to encourage operators to avoid service disruption during severe weather. However, changes in the licence conditions for Heathrow and Gatwick airports introduced in 2014 require operational resilience plans to be produced.
Are actions taking place?		The flooding of Gatwick North Terminal and the subsequent disruption to passengers in December 2013 triggered a review, leading to a comprehensive report and its findings being addressed. Whilst the Government states that the lessons are more generally being applied, there is no evidence of this.
Is progress being made in managing vulnerability?		There is very little data on the impacts from severe weather and the scale of action being taken across the sectors in response. The similarity between the Gatwick and Port of Immingham incidents suggests the practice of siting critical power and IT facilities in basements may be commonplace and this should be addressed as a matter of urgency.

⁴⁶ ASC (2011) *Adapting to climate change in the UK: Measuring Progress*, <http://www.theccc.org.uk/publications/>

⁴⁷ Waterwise (2010) *Evidence Base for Large-scale Water Efficiency in Homes, Phase II Interim Report*, <http://www.waterwise.org.uk/data/resources/14/evidence-base-for-large-scale-water-efficiency-in-homes-phase-ii-interim-report.pdf>

⁴⁸ Green Alliance (2015) *Cutting the cost of water: the case for improving water efficiency in the UK*, <http://www.green-alliance.org.uk/resources/Cutting%20the%20cost%20of%20water.pdf> Savings are based on the average metered water and sewerage bill of £355 per property.

Ports and airports are commercial enterprises whose reputations rely on service continuity during periods of severe weather.

Ports handle 95% of the country's imports and exports (by volume). Half of the UK's port capacity is located on the east coast, where the risk of damage from a tidal surge is greatest. Port operations are also impacted by high winds and fog. Airports are affected by flooding, high winds, freezing conditions, fog and thunderstorms. Heathrow and Gatwick, the two largest UK airports, are the most intensively used single and double runway airports in the world, operating at full capacity during peak hours if not all of the time.⁴⁹

A number of ports were affected by the December 2013 tidal surge, though most were able to resume services promptly. However the Port of Immingham was severely impacted when tide levels reached half a meter above the dock gates. Critical power and IT services were lost and the port ceased operation for a number of days. 75% of the port area was flooded, which also impacted businesses located within the port boundary. Immingham is strategically important for petro-chemicals and fuel, including biomass for energy generation.⁵⁰ Many ports only handle specific cargos, with the largest specialised ports handling twice as much traffic or more as their next biggest competitor.⁵¹ This lack of redundancy means disruption to major ports will have wider consequences.

Gatwick Airport experienced flooding on Christmas Eve of 2013, with intense rainfall leading to flooding of power and IT equipment in the basement of the North Terminal. The disruption of power systems led to the loss of baggage reclaim facilities, check-in and flight information systems, telephone communications, and luggage screening equipment. Flooding of the M23 motorway and closure of the Gatwick train station also affected staff and passenger travel to and from the airport. Flood warnings sent by the Environment Agency on the night of Christmas Eve were not seen or acted upon by duty staff.⁵²

The disruption has spurred activity within both sectors, with lessons learned that will hopefully be applied by operators across both sectors. Given the similar vulnerabilities that led to the loss of services at Gatwick and Immingham, all operators should review the location of critical power and IT facilities as a matter of urgency. Some ports and airports are declining to participate in the second round of reports under the Adaptation Reporting Power, which is a concern.

- Gatwick Airport Limited commissioned a review by David McMillan, a non-executive director.⁵³ The review made 27 recommendations, all of which were accepted by Gatwick's board. The first £5 million of a potential £30 million investment is being spent on improving the resilience of Gatwick's operations. Actions include increasing levels of flood protection (to a 1-in-100 year standard), alternative and back-up power facilities, moving sensitive equipment including IT servers out of basement areas, and a review of the airport's contingency plans. According to the Department for Transport, similar steps are now being taken by Heathrow, and the McMillan report is being used as a blueprint by other airport authorities.⁵⁴
- As of 1st April 2014, the Civil Aviation Authority licence conditions for Gatwick and Heathrow airports now require the two airports to have operational resilience plans aimed at securing continued operation. Summaries of these plans have now been published.^{55,56}

⁴⁹ Richard Brown (2014) for DfT.

⁵⁰ *Ibid.*

⁵¹ ASC (2014).

⁵² David McMillan (2014) for Gatwick Airport Limited. *Disruption at Gatwick Airport*, www.gatwickairport.com/globalassets/publicationfiles/business_and_community/all_publications/2014/mcmillan_report_feb14.pdf

⁵³ *Ibid.*

⁵⁴ DfT (2014).




⁵⁵ Heathrow (2014) *Heathrow's summary operational plan 2014*, www.heathrowairport.com/static/HeathrowAboutUs/Downloads/PDF/Operational_Resilience_Summary-2014.pdf

⁵⁶ Gatwick (2014) *Operational resilience: principles, policies and procedures*, www.gatwickairport.com/globalassets/publicationfiles/business_and_community/regulation/economic_regulation/14-10-01-operational-resilience-report-and-monitoring-report-final-for-publication.pdf

- The risk of tidal surge was identified by the Flood Forecasting Centre six days in advance of the event in December 2013. The Environment Agency and Met Office are continuing to invest in improving their flood forecasting services including for tidal surges.
- Ports in the Humber region are investing in improved protection against tidal surge, including a 1-in-1,000 year standard of protection for the Port of Immingham. This involves a significant upgrade to the port's dock gates. However, further steps are needed to protect the port's landward boundaries from flood water.
- The UK Major Ports Group and the British Ports Association are helping to promote a tidal surge planning template. This helps operators evaluate current resilience, and processes for damage assessment, recovery planning, communications, and workforce planning. Workshops organised by DfT with regional port clusters are continuing. These focus on flood preparations and recovery planning - sharing best practice and linking ports with others in the local resilience community.⁵⁷

There is a general lack of data regarding the overall resilience of ports and airports. This means it is difficult to tell whether lessons from the winter of 2013/14 have now been learned and whether the disruption witnessed is unlikely to be repeated. The above examples of action are encouraging but both sectors need to do more to demonstrate that all appropriate steps are now being taken.

3.3.2d. Roads and the rail network

Is there a plan?		Following the severe disruption to road and rail services in the winter of 2013/14 the independent Brown Review of transport resilience has led to a comprehensive programme of work to address the vulnerabilities identified.
Are actions taking place?		The latest update from DfT regarding implementation of the Brown Review suggests significant action is taking place. For example Weather Resilience and Climate Change Adaptation Plans have been published for each region by Network Rail.
Is progress being made in managing vulnerability?		The rail sector in particular faces a daunting challenge to adapt to climate change. Known vulnerabilities are yet to be addressed and as yet there is no comprehensive assessment of climate risks to the national rail network. Temperatures on the London Underground network routinely exceed comfortable levels. Despite significant investment by TfL this is expected to remain so on the increasing number of hot summer days.

The winter of 2013/14 highlighted that Network Rail in particular faces a significant challenge to upgrade its network to become more resilient to severe weather. This work appears to have accelerated in line with the findings of the independent Brown Review of transport resilience.

England's rail network carries 4.4 million passengers per day on 20,000 miles of railway. Much of the network is 150 years old, and resides in cuttings or on embankments not built to modern standards. For decades, until more recent times, the network suffered from underinvestment in asset maintenance. Meanwhile, passenger journeys have doubled since 1993 with further increases predicted.⁵⁸

⁵⁷ DfT (2014).

⁵⁸ ASC (2014).

Routes are exposed to flooding, coastal erosion, or debris blown on to the tracks and damage to power lines in high winds. The winter storms of 2013/14 caused widespread disruption, most notably with the loss of the main rail route into Cornwall at Dawlish due to the collapse of the sea wall supporting the track. A lack of redundancy in the rail network was also highlighted, with the inland route in to Cornwall also disrupted. Changes in temperature will also pose a challenge, with track needing to be tensioned to suit a wider range of temperatures likely to be experienced in future years.

- There were 105 recorded earthwork failures during the winter of 2013/14 (embankment and cutting landslips). 1,500 trees or substantial branches were blown onto lines. The only route not to experience disruption was the HS1 line to Ashford and the channel tunnel.⁵⁹ Opened in 2009, HS1 cuttings and embankments have shallower slopes and nearby vegetation is more effectively managed.
- The collapsed sea wall at Dawlish took six weeks to repair. Less publicised was the loss for 17 weeks of the link between Harlech and Barmouth in North Wales. With climate change, the length of railway in England (including Dawlish) exposed to coastal erosion is expected to increase from 11 kilometres to 38 kilometres by the 2050s, and to 62 kilometres by 2100.⁶⁰
- One aspect of the rail industry's response to weather warnings that was praised was the pro-active suspension of services before storms struck. This allowed routes to be cleared of vegetation more quickly, and damage repaired, before services were resumed. In many cases passengers were told this in advance, allowing them to make alternative arrangements and avoid becoming stranded, which in turn allowed rail staff to concentrate on restoring the service.

In contrast to the rail sector, the strategic road network has been built since the 1950s, using modern materials and design standards, and has been maintained more consistently over recent decades. Disruptions to the network from severe weather can be managed in the same way as other causes, such as roadworks and major accidents, due to lasting physical damage to roads and assets being unlikely.

- In April 2015 the Highways Agency became Highways England, a strategic highways company owned by the Government. Highways England manages the 4,300 miles of the strategic road network (motorways and trunk A roads) and has published a business plan in response to the Government's Road Investment Strategy.^{61,62} The investment strategy will see £15.2 billion invested in over 100 road schemes over five years. Performance against agreed targets will be monitored by the regulator, the renamed Office of Rail and Road (ORR). £300 million has been allocated to an 'Environment Fund', to address a range of issues including flooding, noise, carbon emissions, landscape and biodiversity. However, it is not clear what this fund will achieve and how the money will be split between the different priorities.
- Highways England has Severe Weather Plans and these have been reviewed and revised in the light of the Brown Review of transport resilience. As well as storms and flooding, the impact of high temperatures has been considered. Similar road surface specifications to those applied in the south of France are used. Drainage standards allow for a 20% increase in rainfall intensity.⁶³

⁵⁹ Richard Brown (2014) for DfT.

⁶⁰ ASC (2014).

⁶¹ See: www.gov.uk/government/publications/highways-england-strategic-business-plan-2015-to-2020

⁶² See: www.gov.uk/government/collections/roads-reform

⁶³ ASC (2014).

In recent years there have been improvements in the information given to drivers to help with route planning and traffic management. Diversions and speed restrictions can be introduced where needed. Lessons have also been learned since July 2007, when 10,000 motorists were stranded on the M5 and M50 motorways due to the lack of turning points on the carriageways that flooded. Flood risks have been assessed and more turning points across central reservations, in critical areas, have been introduced. However, traffic in areas prone to congestion often cannot be diverted due to lack of alternative capacity. Journeys therefore remain vulnerable to disruption.⁶⁴

Much of the Brown Review was dedicated to the rail network, accounting for almost 40% of the sector-specific recommendations. The Government accepted all the review's recommendations and in its latest update summarised where progress is being made. The following are just a few examples of the steps that have been taken in the last twelve months.

- Network Rail has identified the risk of failing to adapt to climate change as part of their board-level corporate risk register. An executive board member is accountable for managing this risk, and scrutinises progress on a quarterly basis.⁶⁵ Regular updates on individual actions are presented to the Department for Transport.
- Weather Resilience and Climate Change Plans have been developed and published for each of the nine service regions (or 'routes'). The plans consider climate change effects, and impacts, and identify specific priorities to increase resilience to weather events. DfT have provided £30 million to manage specific flood risks in the Western Route area. A comprehensive, long-term assessment of vulnerable lines in coastal and estuarine areas, such as Dawlish, has also been completed.
- Network Rail has launched a Vegetation Management Capability Development Programme to introduce new standards and action to manage lineside growth. The budget for vegetation management was increased by £10 million (60%) in 2014/15.⁶⁶ This will help address the risk of train strikes and outages arising from the estimated 2.5 million trees growing near to tracks. In addition, 60% of trees in the 2013/14 winter storms blown on to tracks came from land not owned by Network Rail. This will require increasing co-operation with those owning neighbouring land.
- Tomorrow's Railway and Climate Change Adaptation (TRaCCA) is a programme of research funded by the Railway Safety and Standards Board. TRaCCA aims to deliver step changes in climate science, knowledge of climate change vulnerabilities, and the development of support tools, to increase the weather and climate resilience of the rail network in Great Britain.

London Underground also faces significant challenges. The half of the network that is above ground is exposed to the same climate hazards as railways in general, but with more frequent services, meaning any disruption can have greater consequences. The half of the network that is below ground is exposed to flooding and high temperatures. The deep underground lines that cross central London routinely overheat in summer. Cooling the trains, platforms and tunnels is a difficult technical challenge to overcome.

- During the St Jude's day storm in October 2013 the London Underground network operated normally whereas many other train services in London and the South East had to be suspended. According to the Brown Review this suggests London Underground has made significant progress in managing lineside trees and vegetation, and to address drainage issues, in recent years.⁶⁷

⁶⁴ ICE (2014) *State of the Nation: Infrastructure*, www.ice.org.uk/media-and-policy/policy/state-of-the-nation-infrastructure-2014

⁶⁵ From a discussion with Network Rail staff.

⁶⁶ From a discussion with Network Rail staff.

⁶⁷ Richard Brown (2014) for DfT.

- The 2009 UK Climate Projections suggest that on a summer day by the 2030s, there is a 1-in-4 chance of temperatures being warmer than 24°C, the point at which London Underground's hot weather programme is triggered (up from a 1-in-10 chance today). The hot weather programme involves the 'Stay Cool' public awareness campaign. Passengers are encouraged to carry water and to not travel if feeling unwell. Other measures include siting cooling fans on station concourses.⁶⁸
- As well as trains and other equipment, body heat is a significant contributor to high temperatures on the tube network. London Underground has invested in sophisticated modelling to understand the relationship between train crowding levels and passenger safety during hot weather. This allows targeted investment in assets and operational procedures to alleviate problems.
- London Underground has been upgrading its rolling stock, lines and signals to increase the capacity and reliability of the network, and to minimise instances of trains being held in tunnels. Carriages held in tunnels can quickly overheat and give passengers no easy means of escape.
- New trains being introduced to the shallow 'sub-surface' lines (e.g. the District and Circle lines) include air-conditioning and also allow passengers to move easily between carriages. This makes overcrowding and heat stress less likely. By the end of 2016, 40% of the network will have air-conditioned trains.⁶⁹

Despite these measures, temperatures on the London Underground are likely to remain uncomfortable on hot summer days, which will become more prevalent as the climate changes.⁷⁰

Local roads and highways are managed by district and unitary local authorities. A lack of funding for maintenance in recent years has led to poor surfaces and widespread pot-holing on less travelled routes. Whilst the Department for Transport is actively promoting best practice approaches to managing local roads, backed by a six-year investment programme, local authority budgets for road maintenance are expected to decline further.

Local highways authorities manage 183,300 miles of roads in England, 98% of the total road network. The Brown Review found that a backlog of structural and routine maintenance has built up over recent decades, leaving roads prone to degradation.⁷¹ Water ingress, combined with freezing temperatures, can cause damage to the road surface and potholes to form. Travel can also be disrupted by flooding, and debris in strong winds. High river flows can cause 'bridge scour', where foundations are compromised by the loss of surrounding rock and earth. Bridges carry important services such as gas pipelines, and electricity and telecommunications cables, as well as traffic.

Capital funding for local road improvements is set to rise. From 2015/16 until 2020/21, DfT will allocate £976 million a year to local highways authorities, a 19% increase on the previous funding settlement. In addition, the Department provided £183.5 million in March 2014 for a Severe Weather Recovery Fund, and £168 million in June 2014 for a Pothole Fund.⁷² The DfT-funded Highways Maintenance Efficiency Programme (HMEP) also provides guidance to the local highways sector, to support them to become more efficient. Guidance is being updated to give highways authorities more flexibility in how roads are maintained. The condition of A, B and C roads on the local network has improved since 2012, although the condition of unclassified roads has remained static.⁷³

⁶⁸ GLA (2011) *The London Climate Change Adaptation Strategy*. www.london.gov.uk/sites/default/files/Adaptation-oct11.pdf See also: Arkell, B P; Darch, G J C. (2006) Impacts of climate change on London's transport systems. *Proceedings of the ICE – Municipal Engineer*, vol 159, issue 4.

⁶⁹ See: www.tfl.gov.uk/info-for/media/press-releases/2014/july/tfl-joins-danone-in-giving-out-bottles-of-evian-on-the-tube

⁷⁰ GLA (2011) *The London Climate Change Adaptation Strategy*.




⁷¹ Richard Brown (2014) for DfT.

⁷² Correspondence with DfT.

⁷³ DfT (2015) *Road Conditions in England: 2014 Report*, www.gov.uk/government/statistics/road-conditions-in-england-2014

Local authority revenue budgets for road maintenance have been in decline, and this trend is set to continue. Maintenance of local roads declined by 11% in real terms from 2010/11 to 2014/15.⁷⁴ In a review by the National Audit Office, highways authorities said that reducing the proportion of revenue to capital budgets further would make it difficult to maintain the condition of the networks.⁷⁵ Budget limitations will mean that highways authorities will not be able to maintain all roads to the same standard. The Brown Review recommended that highways authorities identify a sub-set of local roads as a 'resilient network' to prioritise for maintenance.

3.3.2e. Digital infrastructure

Is there a plan?		Adaptation planning in the digital sector remains at an early stage. The first reports under the Adaptation Reporting Power are expected this year, prepared voluntarily by Tech UK and BT Openreach.
Are actions taking place?		The National Adaptation Programme contains no specific actions relating to ICT despite the sector being recognised as pivotal to key infrastructure sectors, as well as the economy in general. There is a lack of evidence in general regarding the actions being taken to reduce the risks from climate change.
Is progress being made in managing vulnerability?		The sector should be inherently resilient, with rapid renewal of equipment and inbuilt redundancy as a result of distributed network and data technologies. However the lack of any evidence from the industry or from the Government to support or counter this assertion is concerning.

The Adaptation Sub-Committee looks forward to seeing the first reports being prepared by the digital infrastructure sector under the Adaptation Reporting Power, due later this year. At present there is little evidence of the extent to which the various components of the country's digital infrastructure are vulnerable to climate hazards, and whether operators are taking appropriate action in response.

Information and communication technologies (ICT) and data services support every aspect of a functioning economy, from controlling traffic lights to handling the billions in daily investment trading on the London Stock Exchange. Every aspect of modern living is becoming increasingly digitised, with sensitive personal information stored and mission-critical data and application services supported by 'cloud' based computing. The cloud in practice consists of server farms that provide secure, reliable and scalable data processing and storage solutions to businesses and the public sector. Consolidating services in to fewer, larger, sites helps with managing security (including cyber security) risks but increases the impact should sites be compromised.

The various components of digital infrastructure are exposed to different climate change risks:

- Fixed line communication and broadband data services rely on a root and branch network comprising trunk cables and exchanges, telephone lines strung between telegraph poles, and street cabinets that serve individual areas. Assets are exposed to high winds including wind-blown debris, flooding, and lightning, with buried cables vulnerable to shrink/swell subsidence. There are anecdotal reports that following the heavy rain and subsequent flooding in Newcastle in June 2012, broadband internet services were down for several days. BT Openreach remains the largest single provider of fixed line services for both voice calls and broadband internet.⁷⁶

⁷⁴ CE (2014).

⁷⁵ NAO (2014) *Maintaining strategic infrastructure: roads*, <http://www.nao.org.uk/report/maintaining-strategic-infrastructure-roads-2/>

⁷⁶ Ofcom (2014) *The Communications Market Report*, <http://stakeholders.ofcom.org.uk/market-data-research/market-data/communications-market-reports/cmr14/>

- As a cellular grid, mobile telephony may be more resilient to severe weather than the fixed line network. If individual mobile phone masts are damaged, voice and data communication services should still be available to the majority of the local population.
- Data centres store digital information and support online web services (web applications). A single large data centre will support thousands of different businesses.⁷⁷ According to Tech UK, the industry body, flood risk is a key consideration in deciding where to locate new data centres. Data centres also need to be kept cool. High summer temperatures, as well as rapid fluctuations in temperature and humidity, pose challenges particularly to older sites.

Disruption to digital infrastructure is seen as a real threat to business. In a survey of business continuity managers, the loss of IT and telecommunications ranked third and fourth respectively in the list of disruptions experienced in previous years (behind severe weather, and loss of staff including from illness).⁷⁸ Loss of IT and telecommunications were ranked first and third respectively in terms of perceived major threats to costs and revenue (loss of site access was ranked second).

Digital communications providers compete on the basis of service reliability, and there are legal requirements for telecoms providers to take steps to protect the security and resilience of their networks and services.⁷⁹ It is likely that commercial incentives and regulatory requirements already mean appropriate safeguards against disruption from severe weather are in place. However evidence from ICT and data service providers would be welcome to support this assertion. Recent extreme events in other countries suggest that impacts are possible.

The legislation that applies to telecoms providers requires them to take measures to protect the security and resilience of their networks and services. Ofcom has the power to intervene if it feels a provider is not taking the appropriate measures.⁸⁰ BT Openreach is working towards the publication later this year of their first report under the Adaptation Reporting Power.

Data centre services offered by third-party providers guarantee site security, power and a high bandwidth internet connection. Providers advertise their services on the basis of reliability tiers, developed by the Uptime Institute.⁸¹ Data centres in the highest tier, Tier 4, are designed to offer 99.995% availability. Tier 3 centres make up the majority of those certified in the UK and United States.⁸² Resilience measures include uninterrupted power supplies, back-up generation, and mirrored storage of data at alternative sites should services be compromised for any reason.

However, Hurricane Sandy in October 2012 led to severe disruption to many data centres in New York and New Jersey. According to Tech UK, a data centre and its mirrored backup site 400 miles away were both affected. As well as those directly impacted, other data centres ceased operation due to power cuts lasting several days. Whilst backup generators were in place, local fuel supplies ran out. In contrast, there were no reported major impacts on data centres arising from the Fukushima earthquake and tsunami in March 2011. In Japan, data centres by law have to be earthquake-proof, and none are located in areas of tsunami risk.⁸³ Tech UK has volunteered to publish an ARP report later this year on behalf of the data centre industry.

⁷⁷ Intellect (2013) *Er, what IS a data centre?*, www.techuk.org/insights/reports/item/1858-data-centre-publications

⁷⁸ Chartered Management Institute (2013) *Weathering the Storm*, <http://www.bsigroup.com/Documents/iso-22301/resources/Weathering-the-storm-CMI-UK-EN.pdf>

⁷⁹ The EU Electronic Communications Act (2009) and the 2010 Digital Economy Act have given the regulator, Ofcom, duties and powers to ensure providers deliver appropriate security and availability.




⁸⁰ Ofcom (2014) *Ofcom guidance on security requirements in sections 105A to D of the Communications Act 2003*, <http://stakeholders.ofcom.org.uk/telecoms/policy/security-resilience/>

⁸¹ See: <https://uptimeinstitute.com/tiers>

⁸² Uptime Institute, *Tier Certification Map*. <https://uptimeinstitute.com/TierCertification/certMaps.php>

⁸³ Case studies provided by TechUK.

3.3.3. Infrastructure interdependencies

Is there a plan?		The importance of interdependencies between networks is recognised and the Cabinet Office has begun focusing on cross sector vulnerabilities as part of their annual resilience review. As yet there is no systematic national assessment of interdependency risk, nor a comprehensive plan to address it.
Are actions taking place?		Individual sectors are reviewing their dependency on other networks, in particular their reliance on power, ICT, and critical road and rail links.
Is progress being made in managing vulnerability?		The Cabinet Office annual resilience reviews have identified and considered specific vulnerabilities to interdependent networks. Outputs from research projects are beginning to quantify the scale of interdependency risks at the national level. However, data that measure progress in addressing vulnerabilities are not yet available.

Infrastructure networks do not operate in isolation, with services in particular reliant on power, fuel supplies, and ICT. Transport links including local roads are important for logistics and to allow staff to travel to work. Failures caused by interdependencies are not systematically recorded, and the scale of the issue remains largely unknown. Investment in resilience by individual operators and sectors may be falling short of what is required in the national interest.

The National Adaptation Programme includes a specific objective to minimise the risk of cascade failures, where a loss of service in one network has knock-on consequences more widely. Recent events have highlighted a few examples of interdependencies, such as the supply of biomass to power stations through the Port of Immingham, inundated in December 2013. Later that month, on Christmas Eve, staff found it difficult to travel to Gatwick airport when both the M23 motorway and the railway station had to be closed.⁸⁴ Disruption to passenger services in the North Terminal overwhelmed the staff numbers available.⁸⁵

Until recently, infrastructure operators had been left to develop resilience plans to suit their own needs, driven by regulatory requirements or their own commercial interests. This means that within and between sectors, operators have been working to different standards of resilience. As discussed earlier, it is not clear whether the minimum 1-in-200 standard for flood resilience for all critical national infrastructure services is now in place. Furthermore, the list of infrastructure assets defined as CNI is a sub-set of those that provide important services to communities and businesses, as well as other infrastructure networks. For example, data centres and broadband services are not generally classified as CNI.

Common standards of resilience would help with investment planning, and help emergency planners better understand the potential for service disruption arising from assets in their area. A good example of a common standard is ETR138, the ‘resilience to flooding’ standard adopted within the electricity transmission and distribution sector.

⁸⁴ Richard Brown (2014) for DfT.

⁸⁵ David McMillan (2014) for Gatwick Airport Limited.

RECOMMENDATION 11: The Cabinet Office should confirm that the services provided by all critical national infrastructure (CNI) are now resilient to a 1-in-200 year flood event. The Cabinet Office should agree, for a wider range of climate risks, sector resilience standards that are in the national interest and see that they are implemented. This process should inform the 2016 round of sector resilience planning.

An ‘annual resilience review’ was initiated after the severe winter storms of 2013/14. Two review cycles are now complete though there is no documented evidence of their findings. The second review cycle focused on critical interdependencies. According to the Cabinet Office, this led to a number of actions discussed and agreed by Ministers.

Prior to the 2013/14 winter storms, the Cabinet Office had identified the potential for national scale disruption resulting from severe weather affecting multiple infrastructure sites concurrently. Work began to assess the vulnerability of ports in particular, and other strategic assets in low lying coastal areas. Following the winter storms, the Cabinet Office work was formalised, extended and announced as an annual review of resilience to be led by the Minister for Government Policy.⁸⁶

Whilst the annual resilience review has not reported in public, partly due to national security concerns, the most recent round of the review has required infrastructure operators to assess their dependency on other networks. The results have led to a series of actions and ministerial-level meetings with regulators and operators. Actions will be followed up as part of the next annual review.

Despite the progress that may be being made behind the scenes, infrastructure operators and local emergency planners remain concerned that they do not have the information they need about other networks, and their interdependencies, to be able to plan for emergencies effectively.

Local Resilience Forums play the lead role in emergency planning. When surveyed by the ASC last year, four out of the 13 LRF coordinators surveyed commented that having limited information on infrastructure assets remained a barrier to effective emergency planning.⁸⁷ There is a similar picture amongst infrastructure operators themselves, regarding other networks and services their assets are reliant upon. Planning for emergencies relies on knowing how likely it is that power, ICT, critical transport networks and public water supplies will become unavailable.

RECOMMENDATION 12: Information on asset and network resilience should be shared between operators of interdependent assets, and with Local Resilience Forums. The Cabinet Office should facilitate the piloting of secure information sharing arrangements within a year of this report’s publication. Based on the results, the Cabinet Office should consider introducing in this Parliament a legal duty to co-operate and share such information.

⁸⁶ See: <https://www.gov.uk/government/news/first-meeting-of-new-cabinet-committee-on-flooding>

⁸⁷ ASC (2014).

Actions in the National Adaptation Programme focus on better understanding the potential for cascading failures, and to promote collaboration between regulators and infrastructure operators. These have provided useful forums to discuss common issues, but this has yet to translate in to tangible action.

The Infrastructure Operators' Adaptation Forum (IOAF) meets quarterly, sponsored by the Environment Agency's Climate Ready service. The forum consists of Government departments, regulators, sector trade associations and individual operators, together with an independent chair.⁸⁸ Meetings generally consist of round-table updates, and presentations from individual members. Plans are now in train to develop a series of workstreams looking at cross-cutting issues, each with specific outputs. Infrastructure UK is also very active, commissioning research on interdependencies and promoting a 'system of systems' approach to new infrastructure provision.

The Infrastructure Transitions Research Consortium (ITRC) is a major, EPSRC-funded programme to develop national models to support long term planning and adaptation of infrastructure systems in a changing climate.

- **Critical hotspots:** ITRC was commissioned by Infrastructure UK to produce a national hot spot analysis of critical cross-sector dependencies on electricity. This suggests hotspots are typically located around the periphery of urban areas rather than in town and city centres. A large number of hotspots also exist outside urban areas, where there are large facilities upon which many customers depend, or where several critical infrastructures are concentrated in one location.⁸⁹
- **Spatially coherent hazards:** ITRC is developing an approach to understanding the chance of concurrent impacts and damages from flooding that could cause disruption at a national scale. The methodology is being applied to create probabilistic simulations of flood events for Great Britain.
- **Analysis of economic impacts:** ITRC is building a model to understand the relationship between infrastructure network failures and impacts on the national economy. The work aims to produce a risk profile assessing the potential scale of economic disruption and the likelihood of losses based on different flood events.⁹⁰

The UK Regulators Network has established an adaptation working group. This has met twice and provides a useful forum to share common issues. UKRN have commissioned work to consider 'interactions' between networks. Within the regulated sectors, operators are not always penalised if severe weather causes disruption; severe weather beyond certain thresholds is ignored for the purposes of performance management.⁹¹ This reduces the incentive for extremes to be planned for and incidents to be managed as effectively as possible. As an example, if Network Rail misses its performance targets because of severe weather, the Office for Road and Rail will instead use the same day in the previous year as the basis for financial penalties. If rail operators decided to run no train services due to severe weather, there would be no penalties because of there being no timetabled services.

⁸⁸ Staff from the Adaptation Sub-Committee secretariat also attend.

⁸⁹ ITRC (2015) *Infrastructure criticality Hotspot Analysis*, <http://www.itrc.org.uk/wordpress/wp-content/PDFs/ITRC-hotspots-summary.pdf>

⁹⁰ See: <http://www.itrc.org.uk/the-cost-of-cascading-failure-risk-and-resilience-within-uk-infrastructure-networks/>

⁹¹ ASC (2014).

RECOMMENDATION 13: The UK Regulators Network should ensure that proportionate and cost-effective approaches to increasing resilience and reducing climate change risks are in place for the economically-regulated sectors. A cross-sector review of reward and penalty regimes should be conducted in time for the ASC's next progress report in 2017, to ensure there are sufficient incentives in place for operators to manage severe weather incidents effectively and preserve services where possible.

3.4 Conclusions on NAP objectives and actions

Table 3.1 summarises progress as far as can be established against the objectives listed within the NAP for the infrastructure theme. In general, the objectives describe a number of processes by which the resilience of national and local infrastructure should be improved.

Of the 91 actions for the Infrastructure theme in the NAP:

- 34 (37%) are complete;
- 46 (51%) are "on-track", although 19 of these actions are not time-bound;
- 7 (8%) have been revised or delayed; and
- no updates were received in relation to four actions.

An annex to this report presents the current status of each action, available on the CCC's website. Very few of the updates from action owners describe how climate change risks have been reduced as a result of their activity.

Table 3.1: NAP objectives and a summary of progress for the infrastructure theme

NAP objective	Commentary on progress
Objective 7. To ensure infrastructure is located, planned, designed and maintained to be resilient to climate change, including increasingly extreme weather events.	<p>60 (66%) of the NAP actions for the Infrastructure theme fall under this objective. All but four of the actions are complete or on-track.</p> <p>Overall, new Nationally-Significant Infrastructure Projects appear to be taking account of the primary climate risks, particularly flooding and sea level rise. Less account is taken of projected changes in water scarcity, subsidence, and groundwater flooding.</p>
Objective 8. To develop regulatory frameworks to support and promote a resilient and adaptive infrastructure sector.	<p>13 (14%) of the NAP actions for the theme support this objective, all of which are complete or on-track.</p> <p>Action by regulators is more apparent in some sectors than others, most notably in the electricity transmission and distribution sector where Ofgem has worked with the industry to develop a comprehensive approach. Ofwat has introduced a new outcome-based performance framework and is working with the sector to develop an approach that fulfils the new resilience duty in the 2014 Water Act. No sector has yet developed performance indicators for resilience that encompass redundancy, reliability, response and recovery. Regulators have the key role to play in helping their sectors address this.</p>
Objective 9. To better understand the particular vulnerabilities facing local infrastructure from extreme weather and long term climate change to determine actions to address the risks.	<p>Eight (9%) of the NAP actions fall under this objective, all but one are complete or on-track. In relation to the one revised action, the Government announced in December 2014 it would no longer introduce the approach to encouraging sustainable drainage systems legislated for in the 2010 Flood and Water Management Act. Instead, use of SuDS is being promoted through the planning system, as discussed in Chapter 2.</p> <p>The primary focus to date has been on improving understanding of climate change, and the resilience of critical national infrastructure. The Environment Agency is also sponsoring work through the LGA's Climate Local initiative to support councils to improve the resilience of local infrastructure, in particular highways. Best practice is being shared through the Local Adaptation Advisory Panel and by Climate UK.</p>
Objective 10. To develop understanding and promote expertise in managing interconnected and interdependent services, to minimise the risks of cascade failures which could be exacerbated by climate change and identify how systems thinking can support this objective.	<p>Ten (11%) of the NAP actions support this objective. All actions are complete or on-track other than two (at the time of writing). Infrastructure UK is due to publish new guidance on interdependencies and systems thinking, delayed from 2014. The Infrastructure Operators Adaptation Forum has taken over an action previously on the Energy Networks Association and water companies to address dependency risks. This has yet to be taken forward.</p> <p>Some progress is being made by the annual resilience review and the Infrastructure Transitions Research Consortium in terms of developing understanding, though this has yet to translate in to measurable progress in reducing the chance of cascade failures. The Infrastructure Operators Adaptation Forum and the UK Regulators Network provide useful means to share lessons.</p>



Chapter 4: Healthy and resilient communities

- 4.1 Climate change and health and well-being
- 4.2 Risks to public health and well-being from climate change
- 4.3 Progress being made
- 4.4 Conclusions on NAP objectives and actions























Key messages

Climate change will lead to changing weather conditions and extreme events such as heatwaves, cold snaps, drought and flooding. These changes are likely to alter the weather-related burden on human health and well-being.

The focus of activity in the National Adaptation Programme is on research and providing guidance to health, social care and emergency planning professionals and the public. Despite the large amount of activity underway, the exposure and vulnerability of people to heat stress in the built environment is increasing. Public awareness of the changing incidence of hot weather and heatwaves appears to be low. There is also a lack of coordination between activities to reduce cold-related health-risks and the risks from heat. There are plans in place and activity underway to improve the capability of the health, social care and emergency planning sectors to respond to extreme weather; increase capacity of people and communities to recover from flooding; and monitor risks to people from air pollution, UV radiation and human pathogens. However, evidence is lacking on whether progress is being made in managing vulnerability in these four areas.

Overview of progress

Adaptation priorities	Is there a plan?	Are actions taking place?	Is progress being made in managing vulnerability?
1. Public understanding of climate change risks			
2. Heat-related health impacts			
3. Cold-related health impacts			
4. Pathogens, air pollution and UV radiation			
5. Capability of the health and social care system			
6. Capability of the emergency planning system			
7. Capacity of people and communities to recover from flooding			

Note: The criteria for Red, Amber, Green or Grey status for each of the three questions are as follows:

Is there a Plan? Green – where needed, plans or policies are in place that fully address the adaptation priority in the context of climate change.

Amber – plans or policies are in place that partially address the adaptation priority. Red – no specific policies or plans are in place

Are actions taking place? Green – all relevant NAP actions are complete or on-track, other relevant actions or commitments are being implemented. Amber – not all relevant NAP actions are on-track, partial delivery of other actions or commitments. Red – NAP actions mostly delayed or dropped, other relevant actions behind schedule.

Is progress being made in managing vulnerability? Green – trends in vulnerability are reducing or not increasing; there is high uptake of low-regret adaptation; long-term decisions are accounting for the future climate. Amber – some trends in vulnerability are increasing; scope to increase low-regret adaptation, decisions partially or inconsistently accounting for the future climate. Red – most trends in vulnerability increasing; minimal or zero uptake of low-regret adaptation; long-term decisions not taking the future climate into account. Grey – there is insufficient evidence to make a judgement.

See Chapter 1 for a full description of the approach.

Summary of progress

Almost all actions in the National Adaptation Programme (NAP) under the healthy and resilient communities theme are complete or on-track. Key areas of progress include:

- **Heatwave and Cold Weather Plans:** Public Health England is implementing and promoting these plans, and both have been updated to encourage year-round planning for temperature extremes.
- **Overheating in homes:** A project led by the Zero Carbon Hub has reviewed the evidence on overheating in homes, and will be providing advice to Government on potential measures to alleviate the risk in early 2016.
- **Guidance for public health and social care organisations:** This has been extended through the 'Under the Weather' toolkit, the Premises Assurance Model, Estates Returns Information Collection, a knowledge hub on emergency planning, and the rollout of the Local Government Association's Climate Local Initiative.
- **Adaptation reporting:** A report has been published for the health sector under the Adaptation Reporting Power, with input from 23 organisations led by the Sustainable Development Unit for the Health and Care System.
- **Surveillance:** Surveillance efforts and data sharing have been enhanced for air pollution, the marine pathogen *Vibrio vulnificus*, norovirus, harmful algal toxins, and UV radiation.
- **Health impacts of flooding:** A Public Health England cohort study on the health impacts of flooding has been initiated, to address evidence gaps on how flooding affects people's health and well-being over the longer-term.

There are two specific areas where further progress is most urgent; managing heat-related risks to public health, and developing a plan to increase public awareness of climate change-related risks.

- **Overheating in buildings:** Current estimates, based on mean temperatures only rather than extremes, suggest that without action, there could be approximately 7,000 heat-related deaths per year in the 2050s, a tripling of the current average.¹ Vulnerability is increasing in relation to overheating in homes. Low-regret passive cooling measures are not yet being put in place, and there are no policies to reduce vulnerability through building design or to increase the amount of greenspace in urban areas. There is also a lack of data on the extent of the problem and what action is being taken to protect vulnerable people from heat in hospitals and care homes.

¹ Hajat et al. (2013) 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* 10.1136/jech-2013-202449.

- **Public understanding of climate change risks:** There are various activities underway to provide information to the public on the risks from extreme weather, such as the Heatwave and Cold Weather plans. However, the few surveys that exist suggest that public awareness of key weather-related risks and how these may be changing is patchy at best. There is no overall Government plan or objective to improve public understanding of climate change risks.

There is also a need to collect more quantitative data on:

- the level of capability of the health, social care and emergency planning sectors for managing extreme weather;
- how exposure and vulnerability to air pollution, pathogens and UV radiation may be changing; and
- the ability of people and communities to recover from flooding.²

Recommendations for further progress

- **RECOMMENDATION 14:** The next NAP, due in 2018, should contain a specific set of actions that aim to increase public awareness of climate change risks. Lead responsibility should be assigned to a single Government Department.
- **RECOMMENDATION 15:** DCLG should, before the ASC's next report in 2017, evaluate the latest evidence and subsequently introduce a new standard or regulation on reducing the risk of overheating in new homes.
- **RECOMMENDATION 16:** DCLG and the Department of Health should develop incentives for the uptake of passive cooling in existing homes, hospitals and care homes and include new measures in the next NAP.
- **RECOMMENDATION 17:** DCLG should adopt a goal of reversing the decline in urban greenspace and work with local authorities to begin delivering an implementation strategy by the time of the ASC's next report in 2017.
- **RECOMMENDATION 18:** Cabinet Office should, before the ASC's next report in 2017, undertake a quantitative assessment of the capability of the national emergency planning system to manage extreme weather events; and in light of the findings, publish a summary outlining where further capability may be needed.
- **RECOMMENDATION 19:** DCLG should work with Local Resilience Forums to instigate a system that quantitatively assesses local capabilities to respond to extreme weather events, with the results to be made available in time for the ASC's next progress report in 2017.
- **RECOMMENDATION 20:** Local authorities should routinely collect and publish data on flood recovery, including the length of time occupants have to wait until they are able to return to their homes after a flood event. DCLG should review the capacity of local authorities to support people physically and mentally in the aftermath of a flood, and publish its findings before the ASC's next report in 2017.

² Chapter 2: Built Environment also provides analysis of actions underway to protect people from flooding.

Vision: “A health service, a public health and social care system which are resilient and adapted to a changing climate. Communities and individuals, including the most vulnerable, are better prepared to cope with severe weather events and other impacts from climate change. Emergency services and local resilience capability take account of and are resilient to a changing climate”

HM Government, 2013 National Adaptation Programme

4.1 Climate change and health and well-being

Climate change will alter weather-related risks to public health and well-being in England.

Climate change will alter the balance of risks to individuals from changes to weather patterns (heat, cold, flooding and drought), air pollution, UV exposure and pathogens. There are also direct risks from extreme weather to the NHS and wider public health and social care assets such as buildings, logistics, business continuity and transportation.

Climate change is also likely to increase pressures on the emergency planning system through more frequent and intense episodes of severe weather. There are uncertainties over the precise timing and extent of the changes. Flexibility is needed to deal with future risks.

Adaptation across the health and social care system and emergency services is important to minimise the current, as well as the potential future impacts on human health and socio-economic well-being from climate-related hazards. These include the risk of death and physical injury, as well as impacts on people’s mental health and well-being more generally.

Climate change will add to other pressures on the health and social care system from a growing and ageing population.

The National Health Service and the public health and social care system is already under pressure. The last quarter of 2014 saw 7.4% of patients waiting more than four hours for treatment in Emergency Departments, the poorest performance for ten years.³ Although life expectancy is increasing, healthy life expectancy has not risen as fast, resulting in proportionately greater demands on the NHS.⁴ The Care Quality Commission’s latest *State of Care* report found that a greater burden from long-term and multiple conditions, and demand from consumers to have access to the latest treatments, are driving up demand significantly. This has contributed to, for example, an increase in emergency admissions of 13% over the past six years.⁵

Pressures on the health and social care services will continue to increase in the future. The UK’s population is projected to increase from 64 million in 2012 to 73 million by 2035. The population aged over 75 is projected to increase from 5 million in 2012 (8% of the total population) to 9.5 million in 2035 (13% of the population).⁶

Efficiency savings in the NHS have been made between 2010-2015. The Commons Health Committee stated in its most recent report however that there is ‘no evidence that the transformation of care that is needed to make the NHS sustainable in the long-term has started to take place.’⁷

³ See: <http://qmr.kingsfund.org.uk/2015/14/data/#/9effc397-0668-43b2-919f-8e74a560ac0a>

⁴ House of Commons (2010) *The ageing population*, <http://www.parliament.uk/business/publications/research/key-issues-for-the-new-parliament/value-for-money-in-public-services/the-ageing-population/>

⁵ See: <http://www.cqc.org.uk/content/state-care-201314>

⁶ Office of National Statistics (2014) *National Population Projections, 2012-Based Projections Release*, <http://www.ons.gov.uk/ons/rel/npp/national-population-projections/2012-based-projections/stb-2012-based-npp-principal-and-key-variants.html>

⁷ House of Commons Health Committee (2014) *Public expenditure on health and social care*, <http://www.publications.parliament.uk/pa/cm201314/cmselect/cmhealth/793/793.pdf>

NHS England has set out its strategy for addressing these concerns in its Forward View.⁸ This strategy includes a range of initiatives that are underway and a commentary on what remains to be done.

4.2 Risks to public health and well-being from climate change

As well as the direct risks to physical health, climate change will impact on people's mental health, and social and economic well-being.

There are large uncertainties in projecting future impacts of climate change on health due to a lack of understanding of current vulnerability, the effects of changing weather patterns on exposure, and uncertainties over the extent to which people will adapt physiologically to changing conditions such as higher temperatures. The latest evidence suggests that:⁹

- **Cold weather** is currently the largest weather-related driver of mortality, contributing to between 35,500 and 49,400 deaths per year. This is projected to decrease slightly through time as winters warm, but an ageing population is likely to counteract the benefits from climate change and the total number of cold-related deaths is only projected to decrease slightly by 2050.
- Whilst average temperatures are expected to increase, there will remain a chance of **cold snaps and heavy snow** through the rest of the century.
- **Heat-related deaths** are currently around 2,000 per year but are projected to increase to around 7,000 per year by 2050 in the absence of additional action. These projections only consider rising mean temperatures and do not include the effects of more extreme heatwaves.
- Best estimates suggest that **ground level ozone** contributes to between 1,200 and 11,500 deaths per year. Future impacts due to climate change are uncertain, and depend on aspects of climate that are difficult to model, such as future trends in wind direction.
- The effects of climate change on exposure to **UV radiation** are highly uncertain, and likely to be outweighed by changes in lifestyle and behaviour (such as use of sun lamps and exposure to the sun overseas). The number of people currently dying from melanomas (skin cancer) is around 2,000 per year.
- The potential changes in prevalence and pattern of **infectious and non-infectious diseases** from climate change also remains uncertain. Good evidence exists on the sensitivity of different pathogens and vectors to the climate, but it is very difficult to predict which diseases may pose the greatest risk in the future.
- **Health and social care staff, resources and assets** are at risk from extreme weather. For example, 10 – 14% of emergency service stations and 6 – 8% of hospitals, care homes and surgeries in England are located in flood risk areas.
- Climate change is likely to increase the chance of **weather-related emergencies**, though the precise changes in frequency and intensity of specific events is uncertain. It is important therefore to have an emergency planning system that is well prepared for extreme weather now and can be scaled up in the future if need be.

⁸ See: <https://www.england.nhs.uk/wp-content/uploads/2014/10/Syfv-web.pdf>

⁹ All mortality statistics are for the UK. See ASC (2014) for more details and references.

In response to these risks, the Government's National Adaptation Programme sets four objectives for the healthy and resilient communities theme.

The objectives were identified following consultation across a wide range of stakeholders with expertise in climate change and health and well-being, including Government departments, non-departmental public bodies and voluntary-sector organisations.

- **Objective 11:** To reduce the risk of death and illness associated with severe weather events and climate change and increase preparedness and resilience to the impacts on public health.
- **Objective 12:** To promote climate resilience within the NHS, public health and social care system to ensure continuity of services and resilient assets/estates, including the ability to deal with the increased demand for services associated with severe weather related events.
- **Objective 13:** To minimise the impacts of climate change on vulnerable groups in society by strengthening their resilience to better prepare for, respond to and recover from future climate risk.
- **Objective 14:** To promote and strengthen community resilience to severe weather related events linked to climate change (preparation, response and recovery), and the climate resilience of the emergency services and other Category 1 and 2 responders of the Local Resilience Forums (LRFs).

The NAP objectives describe important high-level principles and processes for adaptation related to health and well-being. We have reviewed progress by the actions in the NAP against each objective in Section 4.4 below.

Figure 4.1: Climate hazards, contextual factors and adaptation priorities for the healthy and resilient communities theme




Climate hazards	Contextual factors	Adaptation priorities	Examples of relevant NAP actions
High temperatures	Growing, ageing, population	Public understanding of climate change risks	<ul style="list-style-type: none"> • Update and publish the Heatwave and Cold Weather Plans • Review housing policies and regulations in relation to heat and cold • Implement Green Infrastructure Partnership work on adaptation • Improve surveillance and warnings for air pollution, water-borne and vector-borne diseases, and UV radiation
Low temperatures		Heat-related health impacts	
Flooding		Cold-related health impacts	
Drought		Pathogens, air pollution and UV radiation	
High winds	Urbanisation	Capability of the health and social care sector	<ul style="list-style-type: none"> • Publish the 'Under the Weather' toolkit • Promote/implement NHS emergency planning guidance and reporting through the NHS premises assurance model, SHAPE tool, business continuity frameworks • Review national best practice guidance on design, engineering, and operation of healthcare facilities for flood risk and extreme temperatures
Wildfire	Migration		
Exposure to pathogens	Behaviour change		
UV radiation	Public expectations	Capability of the emergency planning sector	<ul style="list-style-type: none"> • Local Resilience Fora, local responders, communities and civil society to build community resilience • Maintain community resilience knowledge hub • Chief Fire Officers' Association (CFOA) and NHS Sustainable Development Unit (SDU) to report on a voluntary basis under the Adaptation Reporting Power • Promote climate resilience and adaptation within the Ambulance Service • Fire and Rescue Service to review risk/capability to deal with a severe wildfire
Air pollution	Social inequity		
	Land use change		
	Service provision		
		Capacity of people and communities to recover from flooding	<ul style="list-style-type: none"> • Environment Agency Climate Ready to share information on vulnerable groups.

However, as described in Chapter 1, the objectives broadly describe a direction of travel rather than outcomes, and they also conflate the climate-related risks to health outlined above. This makes it difficult to measure and assess the progress being made with their implementation, against the risks set out in the UK Climate Change Risk Assessment (CCRA). We have therefore structured our assessment according to a set of more specific and measurable 'adaptation priorities' (Figure 4.1). The figure also illustrates some of the relevant actions in the NAP for each of these priorities.

4.3 Progress being made

This section evaluates the extent to which the actions and policies in the NAP and elsewhere are addressing the identified climate risks, following the method described in Chapter 1. Further details and the underlying evidence supporting this analysis can be found on the CCC's website.¹⁰

4.3.1. Public understanding of climate change risks

Is there a plan?	 Red	While there are individual public awareness plans and warning systems for specific hazards such as flooding and heatwaves, there is no overall plan to communicate climate risks to the public, how risks are changing over time, and the steps people can take now to build resilience.
Are actions taking place?	 Green	The Heatwave and Cold Weather alerts, flood warnings, and air pollution and UV warning services aim to provide the public with information about upcoming extreme events and how to protect themselves. Actions are being taken to update and improve all of these services.
Is progress being made in managing vulnerability?	 Amber	There is little information available on the level of public understanding of climate change risks. While the NAP includes a large number of actions related to providing guidance and information, owners of these actions have not yet evaluated their effectiveness. Surveys that do exist suggest that the public understanding of the changing risks from cold and heat, for example, are low.

A key focus for the healthy and resilient communities theme in the NAP is the improvement of general awareness and the capacity to adapt to climate change.

Forty per cent of the actions in the healthy and resilient communities theme of the NAP relate to awareness raising and building capacity. The majority of these actions are complete or on-track.

Some examples of actions related to increasing public awareness include:

- Public Health England continues to publish the **Heatwave and Cold Weather Plans** on an annual basis, and holds annual seminars to review the plans. These plans provide guidance to the public and organisations about how to reduce the exposure of vulnerable people to heat and cold. Both plans now include a section on long-term planning.¹¹
- The Government introduced **five-day air pollution forecasts** for the public in 2014.¹²
- **Real-time UV index data** from Public Health England monitoring stations is now displayed on the Defra UK-AIR website.

¹⁰ See: <http://www.theccc.org.uk/publications/>

¹¹ See: <https://www.england.nhs.uk/ourwork/eprr/sw/>

¹² See: <http://uk-air.defra.gov.uk/>

- The Government has published a series of information leaflets for the public on the **health effects of flooding**.¹³

The available evidence suggests that public awareness of how climate-related risks are changing is patchy, with greater awareness of flooding and less for heat and cold. Awareness may be influenced by recent experience.

The NAP and Climate Ready service are specifically aimed at private and public sector organisations and the voluntary sector, rather than the public. The NAP does not consider in its objectives the level of public awareness of climate change risks nor the benefits of this improving over time.

There are some signs that the reach of extreme weather warnings is improving over time. For example, the number of people signed up to the Environment Agency's flood warning scheme has increased to over 50% of all households in areas at risk, in part due to the introduction of a new opt-out service.¹⁴ The Defra PREPARE survey (Figure 4.2) also suggests that there is fairly good awareness that flood risk is likely to increase in the future.¹⁵

However, other sources of evidence suggest that the level of perceived individual risk is low. For example, an Environment Agency survey found that fewer than 10% of people living in areas at flood risk appear to know and accept that they are at risk.¹⁶ This low level of awareness could partly explain the low uptake of household property-level flood protection, and permeable paving, in flood-risk areas (see Chapter 2: Built Environment).

While the PREPARE survey suggests that the public are generally aware that flood risk is likely to increase, the opposite is true for heat. The study concluded that *'heat waves and hot summers are generally not considered a realistic threat. They are thought to be no more common than they used to be, nor any more severe, and are unlikely to become more common by 2050.'* Only 11% of those surveyed felt that hot weather had become more frequent (Figure 4.2). Met Office figures show that in reality, the number of hot days per year has increased from around 10 on average in the 1960s to around 25 per year over the past decade.¹⁷ The study also stated that only 29% of people thought that hot summers would become more common in the future; it ranked lowest in the list of all of the hazards discussed. In fact, the evidence for increasing summer temperatures is more robust than for most other climate variables; latest estimates suggest that summers as hot as 2003 could become a 1-in-2 year event by 2050.¹⁸ A greater percentage of respondents thought that cold winters and snow would become more common in the future (Figure 4.2), whereas both are likely to decline.¹⁹ The study noted the link between the weather in the UK at the time of the survey (cold and wet) and people's views of how the climate was changing. This could indicate that recent experience may bias people's perceptions of future weather trends.

¹³ See: <https://www.gov.uk/government/collections/flooding-health-guidance-and-advice>

¹⁴ ASC (2014) *Managing climate risks to well-being and the economy*, <http://www.theccc.org.uk/publication/managing-climate-risks-to-well-being-and-the-economy-asc-progress-report-2014/>

¹⁵ See: <http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&ProjectID=18552>

¹⁶ Harris Interactive (2013) for the Environment Agency.

¹⁷ The number of hot days per year is defined as the number of days exceeding the 1993-2006 93rd percentile of 2-day maximum temperature.

¹⁸ Met Office (2014) *Too hot, too cold, too wet, too dry: drivers and impacts of seasonal weather in the UK*, http://www.metoffice.gov.uk/media/pdf/4/8/Drivers_and_impacts_of_seasonal_weather_in_the_UK.pdf

¹⁹ *Ibid.*

Figure 4.2: Public perceptions of climate-related risks

Figure 4.2a) Question: During your life in the UK do you feel the following have become more or less frequent in the UK, or stayed about the same?

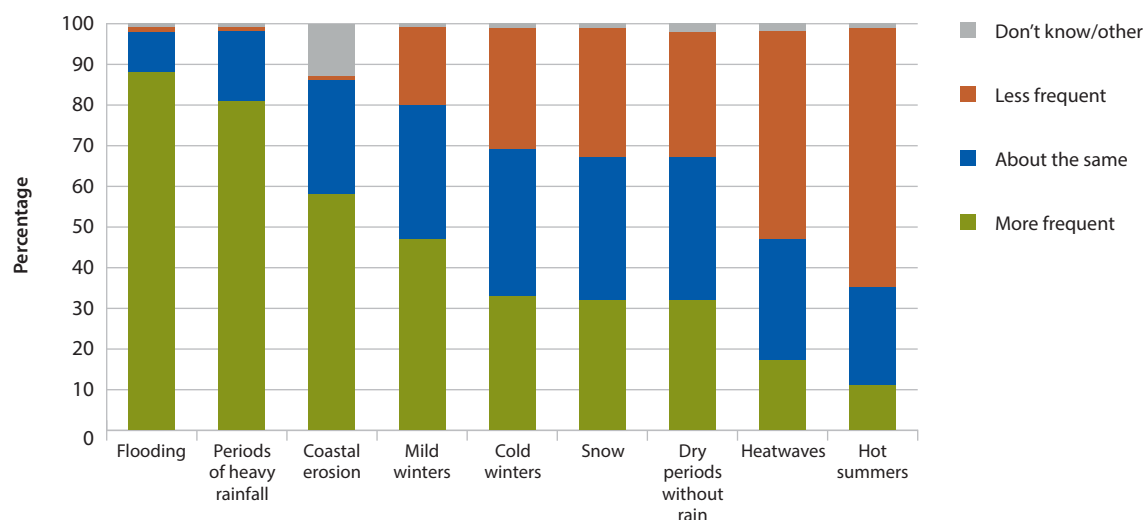
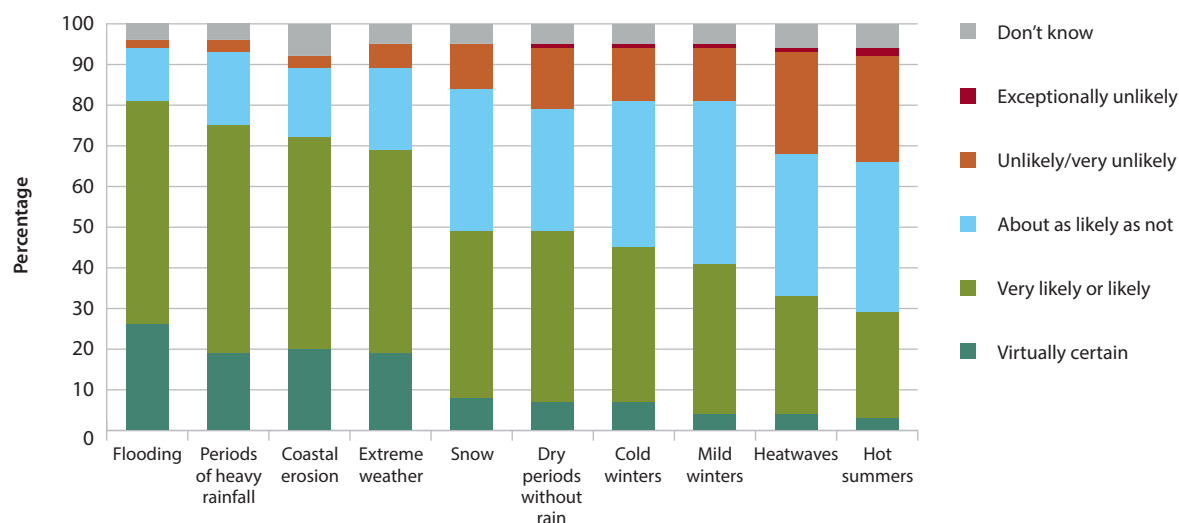


Figure 4.2b) Question: How likely, if at all, do you personally think it is that the following will have become more common in the UK by 2050?






Source: Ipsos MORI Research Institute (2013) *PREPARE - Climate risk acceptability*. Findings from a series of deliberative workshops and online survey, part of the PREPARE Programme of research on preparedness, adaptation and risk. Final Report for project ERG1211 managed by Ricardo-AEA for Defra. Report reference Ricardo-AEA/R/ED58163/PREPARE R3/Issue 1.0.

Notes: The sample size for this survey was 2,007 people and the survey was conducted between 30 January and 5 February 2013.

RECOMMENDATION 14: The next NAP, due in 2018, should contain a specific set of actions that aim to increase public awareness of climate change risks. Lead responsibility should be assigned to a single Government Department.

4.3.2. Heat-related health impacts

Is there a plan?		The Heatwave Plan for England provides guidance on preparing for and responding to hot weather and is aimed at the public, and health and social care organisations. There is currently no plan to reduce the overall exposure of vulnerable people to heat through changes to the built environment, for example by increasing the uptake of passive cooling measures in homes, although the importance of this is emphasised in the Heatwave Plan.
Are actions taking place?		Multiple research projects and guidance documents have been published since 2013 that provide evidence on the risks and information on adapting to overheating risk in buildings.
Is progress being made in managing vulnerability?		<p>The available indicators suggest that vulnerability to heat is increasing. There is a lack of evidence that the actions being taken through the NAP are having an impact on vulnerability.</p> <p>In addition, policies to increase air tightness and insulation of homes in order to reduce carbon emissions could potentially increase the risk of overheating, in the absence of measures to mitigate this risk.</p>

Hot weather currently contributes to around 2,000 deaths per year across the UK. Vulnerability to heat is increasing across a number indicators, and climate change is likely to increase the risk further.

Vulnerability to heat is already an issue for health. Currently there are an average of 2,000 heat-related deaths per year. The UK population spends around 90% of their time indoors, so it is likely that the indoor environment plays a significant role in cases of overheating.²⁰

Studies conducted to assess the current level of risk have found that up to 20% of homes already exceed defined thresholds for overheating or are reported to be overheating by occupants, even in a cool summer.²¹ Flats, which are generally more at risk of overheating than houses, now make up around 35% of new dwellings compared to 15% in 1996.²² Research carried out under the De2RHECC research programme has shown that temperatures in some hospital wards can exceed 30°C when the external temperature is only 22°C.²³ The risk of overheating in care homes is currently unknown. The number of people aged over 75, who are more vulnerable to heat, has increased by 0.8 million to 4.1 million over the last 20 years.²⁴ Parks and green spaces deliver a range of benefits including mitigating the urban heat island effect, but the total area of urban greenspace has declined by 7% since 2001, though the rate of decline has slowed since 2008. Two-thirds of this decline has been caused by the paving over of front gardens.²⁵

²⁰ ASC (2014).

²¹ For example BRE (2011) for DECC *Energy Follow-up Survey Report 1: Summary of Findings*, <https://www.gov.uk/government/statistics/energy-follow-up-survey-efus-2011>, and Beizaee et al. (2013) National survey of summertime temperatures and overheating risk in English homes. *Building and Environment* volume 65, July 2013, pages 1 – 17.

²² NHBC (2015) *New Homes Statistics Review*, http://www.nhbc.co.uk/cms/publish/consumer/NewsandComment/Stats/Q1_2015.pdf

²³ Short, CA et al. (2012) Building resilience to overheating into 1960's UK hospital buildings within the constraint of the national carbon reduction target: Adaptive strategies. *Building and Environment* volume 55, 73-95.

²⁴ HR Wallingford (2014) for the ASC *Indicators to assess the resilience of health and emergency planning in England to the projected impacts of climate change*, <http://www.theccc.org.uk/publication/managing-climate-risks-to-well-being-and-the-economy-asc-progress-report-2014/>

²⁵ *Ibid.*

Climate change is likely to increase the risk of overheating further. Increasing mean temperatures alone could contribute an extra 3,000 deaths per year in the 2050s compared to today, with a growing and ageing population also contributing an additional 2,000 extra deaths. Future projections of extreme heat, rather than increases in average temperature, are uncertain and studies are only just beginning to consider the impact on mortality of future heatwave frequency and intensity.²⁶

The National Adaptation Programme contains numerous actions to improve the evidence base on the causes, extent, and potential measures to control overheating in the built environment.

Since 2012, a range of evidence reports, guidance and training materials have been published by the EA Climate Ready programme, Zero Carbon Hub, NHBC Foundation, Department for Energy and Climate Change, London Climate Change Partnership, and Innovate UK (formerly the Technology Strategy Board). These cover the causes, extent and ways to prevent overheating in buildings. The BREEAM (Building Research Establishment Environmental Assessment Method) new construction scheme now includes requirements for adapting to climate change, and the Building Research Establishment (BRE) has also created a centre for resilience, focussing on research and innovation to climate-related risks in the built environment.

The EPSRC's Adaptation and Resilience to a Changing Climate (ARCC) research programme has funded five projects looking at various aspects of overheating in the built environment, including in hospitals and care homes.²⁷

Two NAP actions on overheating have been revised. DECC has an action to undertake a review of the Standard Assessment Procedure in relation to overheating in 2015. This is still going ahead, but DECC has queried the relevance of focussing on this particular aspect of Building Regulations in relation to overheating. A NAP action for DECC to work with the Good Homes Alliance to better understand overheating in new homes has been subsumed under the Zero Carbon Hub overheating project, which will publish its final report in early 2016.

There is insufficient evidence to determine the uptake of passive cooling measures in homes, hospitals, care homes or other buildings.

Around 80% of the building stock that will be standing in 2050 has already been built, so adapting existing homes for hot weather is a major component of the overall adaptation response. At present, there is insufficient data to determine a trend in the uptake of passive cooling measures in new or existing homes, hospitals, care homes or other buildings.²⁸ There is also insufficient evidence in the updates from NAP action owners to ascertain if the increase in guidance and information on overheating is having any impact on the behaviour of householders.

A recent survey by BRE found that 3% of a sample of 2,000 homes use air conditioning units, while 43% used fans to try to reduce internal temperatures.²⁹ Neither of these methods is ideal for cooling homes. Even if run from low carbon electricity sources, air conditioning is expensive (and therefore may exacerbate social inequalities) and expels waste heat into the environment.³⁰ Fans can provide some benefit at temperatures less than 35°C, but also increase energy use and can exacerbate dehydration.³¹ There have been no studies to date looking at the uptake of low-regret, structural means of passive cooling, such as installing window shutters, tinted window film, or insulating pipes.

²⁶ Hajat et al. (2013).

²⁷ See: <http://www.arcc-network.org.uk/>

²⁸ ASC (2014) and ASC (2011) *Adapting to climate change in the UK – measuring progress*, <http://www.theccc.org.uk/publication/adapting-to-climate-change-in-the-uk-measuring-progress-2nd-progress-report-2011/>

²⁹ BRE (2011) for DECC.

³⁰ ASC (2011), ASC (2014).

³¹ Public Health England (2015) *Heatwave Plan for England*, <https://www.gov.uk/government/publications/heatwave-plan-for-england>

Current regulations and other policies do not currently require standards to be met in relation to overheating in homes, hospitals or care homes.

Current Building Regulations do not contain requirements to avoid overheating for reasons related to health or thermal comfort in homes. Part F (ventilation) and Part L (conservation of fuel and power) include statutory guidance relating to internal temperatures, but these are driven by the desire to regulate indoor air quality and conserve energy. DCLG considered adaptation in its review of the framework of Building Regulations and local housing standards in 2014. The Department declined to introduce new measures on overheating in buildings at the time due to a perceived lack of evidence of their benefits, but stated it would keep research, including that currently being carried out by the Zero Carbon Hub, under review.

The Department of Health has guidelines for new healthcare buildings, whereby internal temperatures should not exceed 28°C for more than 50 hours per year. Care Quality Commission guidance also states that users should be able to control internal temperatures, but does not set limits. There are no upper temperature guidelines for work places, public transport or schools at present, other than that temperatures should be reasonable.³²

There is now enough evidence to support the creation of a new standard or regulation to avoid overheating in new homes.

The Zero Carbon Hub, at the request of the Government, published a series of evidence reviews in March 2015 and an interim report in June 2015 on the causes and extent of overheating in the built environment. Its main observations were that:

- the causes and risk factors associated with overheating in homes are generally well understood by the sector and this knowledge should be used to help target mitigation efforts to the properties and people most at risk;
- despite gaps in evidence, action to address overheating in homes is warranted now; and
- incentives are needed for housing providers to systematically address overheating risk at a level that is in line with the risk.

The Zero Carbon Hub project will consider the shape of future policies and the costs and benefits of different approaches to avoid overheating in its final report.

The ASC's 2014 progress report referred to a number of lines of evidence that support the case for a new standard or regulation on overheating in new homes. Evidence on the costs of overheating in relation to health is well-established. Mortality increases on average by 3.1% for every 1°C increase in outdoor temperature above a specific threshold temperature, that varies by region.³³ A study looking at the economic impact of the 2003 heatwave also suggested it may have had a significant health cost.³⁴

ASC analysis suggests that if air-conditioning is used in both existing and new homes, it would cost society an additional £2 billion (existing homes) and £400 million (new homes) respectively over 15 years compared to passive cooling measures, given projected future electricity prices.³⁵ The passive cooling measures included in the study were opening windows, shutting curtains, reducing heat from electrics, painting roofs white, installing tinted window film, ventilation, and external shading.

³² ASC (2014).

³³ Jenkins et al. (2014) Probabilistic spatial risk assessment of heat impacts and adaptations for London. *Climatic Change* 124: 105 – 117.

³⁴ Hunt, Boyd and Taylor (2007) for Defra, *Report on the costs of the hot summer of 2003*. The study projected a range between £14 million and £2.6 billion. The large range in potential cost results from two ways to monetise mortality. The lower end of the range uses Value of a Life Year (VOLY), while the upper uses the Value of a Prevented Fatality (VPF).

³⁵ Davis Langdon (2011) for the ASC *Research to identify potential low-regret adaptation options to climate change in the residential buildings sector*. <http://www.theccc.org.uk/publication/adapting-to-climate-change-in-the-uk-measuring-progress-2nd-progress-report-2011/>

Separate research has suggested that integrating adaptation measures that reduce internal temperatures by 1 - 2°C could reduce heat-related mortality by 30 - 70% in the 2050s.³⁶

Despite being cost-beneficial compared to air conditioning, there are several reasons why householders may not be taking up passive cooling measures in existing homes at present:

- **Individual perception of risk.** There appears to be low awareness that hot weather has increased, or that hot summers and heatwaves are likely to increase in frequency in the future (Figure 4.2). In addition, while people can easily assess their own thermal comfort, vulnerable people such as the elderly and those with pre-existing medical conditions may not be aware that they are more at risk of cardiovascular and respiratory failure during warm or hot weather. They may therefore be unable to assess the benefits of installing cooling measures in homes or undertaking preventative behaviours.³⁷
- **Social inequalities.** Some householders may be unable to afford the costs of additional cooling measures, whether passive cooling or air conditioning. This has been observed in US cities.³⁸ People living in the rented sector also have less control over making changes to their homes.

In addition to these issues, there is a lack of incentives for developers to bear the up-front costs of installing passive cooling measures in new homes. It is apparent that existing industry guidance is not proving effective at controlling the problem, given that several studies have noted a particular risk of overheating in homes built since 1990.³⁹ Because there is a low level of public awareness of the benefits of passive cooling measures in homes, developers are unlikely to be successful at transferring the costs of these measures through the property price to the home owner. In addition, even if the benefits of passive cooling measures were correctly valued by home owners, they might be unaffordable for some households.

RECOMMENDATION 15: DCLG should, before the ASC's next report in 2017, evaluate the latest evidence and subsequently introduce a new standard or regulation on reducing the risk of overheating in new homes.

RECOMMENDATION 16: DCLG and the Department of Health should develop incentives for the uptake of passive cooling in existing homes, hospitals and care homes and include new measures in the next NAP.

Trends in indicators suggest more needs to be done to halt the decline in urban greenspace. Doing so would have multiple benefits across a number of areas related to climate change adaptation.

Green infrastructure provides multiple benefits to urban populations and the natural environment, including:

³⁶ Jenkins et al. (2014).

³⁷ NHBC (2012) *Overheating in new homes – a review of the evidence*, <http://www.nhbcfoundation.org/Publications/Research-Review/Overheating-in-new-homes-NF46>. Heat-related mortality starts to occur above temperatures of 17 - 20°C, depending on the region.

³⁸ O'Neill et al. (2005) Disparities by race in heat-related mortality in four US cities the role of air conditioning prevalence. *Journal of Urban Health* 82(2): 191 – 197.

³⁹ Good Homes Alliance (2014) *Preventing overheating: investigating and reporting on the scale of overheating in England, including common causes and an overview of remediation techniques*; Beizaee et al. (2013); NHBC (2012).

- **Urban cooling:** studies looking at the ability of parks and other vegetation to cool surrounding areas have shown a noticeable effect. The current green area of London may cool the city by as much as 2 – 3°C.⁴⁰ A separate study for Manchester found that increasing the area of urban greenspace by 10% could result in additional cooling of 2.5°C by the 2080s under a high emissions scenario.⁴¹
- **Sustainable urban drainage (SuDS):** Urban creep can increase the risk of surface water flooding by reducing natural infiltration during intense rainstorms. Using greenspace as part of a SuDS system in new development avoids the need increase sewer capacity.⁴²
- **Biodiversity:** urban greenspace provides an additional range of biodiversity benefits, with higher quality and well-connected patches generally supporting a greater richness of species.⁴³
- **Enhanced well-being:** a range of epidemiological studies have provided evidence of a link between life expectancy and access to greenspace, and between greenspace and self-reported health.⁴⁴

Urban greenspace is therefore a crucial component of climate change adaptation in urban areas (for more on this, see Chapter 2: Built Environment).⁴⁵ The area of urban greenspace in England has declined by 7% (74,000 hectares) since 2001. While the decline has slowed in recent years it has not yet halted.

The NAP includes an action for the Green Infrastructure Partnership to promote the benefits of urban greenspace in planning. A pilot exercise with Sustainability West Midlands has led to several Local Enterprise Partnerships building green infrastructure into their investment priorities, but funding is lacking to expand this further.

RECOMMENDATION 17: DCLG should adopt a goal of reversing the decline in urban greenspace and work with local authorities to begin delivering an implementation strategy by the time of the ASC's next report in 2017.

4.3.3. Cold-related health impacts

Is there a plan?		<p>Public Health England publishes guidance to organisations and the public during cold snaps through the Cold Weather Plan. The Plan provides advice on what steps to take throughout the year to minimise impacts on health from cold weather.</p> <p>The strengthening of Government energy efficiency standards for new homes, and policies to improve energy efficiency in existing homes through the Energy Company Obligation, private rented sector energy performance standards and fuel poverty targets, are likely to reduce the number of cold homes in winter <i>if</i> uptake of measures is widespread.⁴⁶</p>
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40 Walker Institute (2013) *London's urban heat island – research highlights 2010*, <http://www.walker-institute.ac.uk/publications/brochures/highlightarticles/B01833%20Walker%20Institute%20brochure%20pp32-35.pdf>

41 Gill et al. (2007) Adapting cities for climate change – the role of the green infrastructure. *Built Environment* Vol. 3, No.1, pages 115 – 133.



42 Houston et al. (2011) for the Joseph Rowntree Foundation *Pluvial (rain-related) flooding in urban areas: the invisible hazard*, <http://www.jrf.org.uk/publications/pluvial-flooding-invisible-hazard>

43 Angold et al. (2006) Biodiversity in urban habitat patches. *Science of the Total Environment* Vol 360, Issues 1 – 3, pages 1 – 4.

44 Tzoulas et al. (2007) Promoting Ecosystem and Human Health in Urban Areas using Green Infrastructure: A Literature Review. *Landscape and Urban Planning* 81, 167 – 178; National Ecosystem Assessment (2011), Chapter 10, <http://uknea.unep-wcmc.org/Resources/tabid/82/Default.aspx>

45 Demuzere et al. (2014) Mitigating and adapting to climate change: multi-functional and multi-scale assessment of green urban infrastructure. *Journal of Environmental Management* 146C: 107 – 115.

46 See Chapter 2 - Meeting Carbon Budgets - Progress in reducing the UK's emissions: 2015 Report to Parliament.

Are actions taking place?		<p>In 2014, the NHS spent £700 million on measures to deal with increased hospital admissions during cold weather, and prepares each year for a surge in demand in the winter. The Department of Health has funded an independent evaluation of the Cold Weather Plan. The Cabinet Office also coordinates a winter resilience network.</p> <p>In March 2015, DECC provided £1 million through the Fuel Poverty and Health Booster Fund, to scale up nine local authority fuel poverty schemes that target those with health conditions.</p>
Is progress being made in managing vulnerability?		<p>The average Standard Assessment Procedure (SAP) energy efficiency rating of homes has increased from less than 45 in 1996 to 60 in 2013. The percentage of homes with damp or mould problems has decreased from 10% of dwellings in 2003 to 5% in 2011.</p> <p>Although it has declined since 1950, excess winter mortality in the UK is still higher relative to all other northwestern European countries once differences in winter temperatures are taken into account. The benefits of milder winters in terms of reduced cold-related mortality will also be counteracted by an ageing population, suggesting action is still needed to reduce vulnerability.</p>

Cold temperatures are currently the largest weather-related contributor to deaths and illness in England, and are likely to remain so in future decades, even with climate change.

Adaptation to cold is an important part of the country's overall climate change adaptation response for two reasons:

- Cold winters will still occur in the future, albeit with declining frequency over the course of the century. Rarer occurrences may mean that the country is less prepared when cold snaps do occur.
- Although warmer winters are projected to reduce the risk of cold-related mortality, much of this benefit may be countered by an increasingly vulnerable, ageing population. Projections that include climate change and ageing suggest a slight decline of 1,000 cold-related deaths per year in the UK by the 2050s.⁴⁷ Without additional action, cold weather is likely to remain the largest weather-related contributor to mortality in future decades, with between 20,000 and 40,000 cold-related deaths per year in the 2050s.

The NAP focusses on implementing and evaluating the Cold Weather Plan for England.

The Cold Weather plan is led by Public Health England and informs the Cabinet Office's winter resilience network. The Department of Health has funded an independent evaluation of the plan which will be completed later in 2015. There are also multiple activities underway that aim to increase awareness and provide guidance on preventing health impacts during cold weather. Some examples include the 'Getting Ready for Winter' website,⁴⁸ and the NHS/PHE 'Keep Warm, Keep Well' webpage and information leaflet.⁴⁹

⁴⁷ Hajat et al. (2013).

⁴⁸ See: <http://www.metoffice.gov.uk/learning/get-ready-for-winter>



⁴⁹ See: <http://www.nhs.uk/Livewell/winterhealth/Pages/KeepWarmKeepWell.aspx>

Policies in place to reduce carbon emissions in homes through better insulation should, if implemented, help to reduce vulnerability to cold. Action to increase the thermal efficiency of homes should be done in such a way so as not to increase the risk of overheating.

With 2.3 million people living in fuel poverty in England in 2013, it is important that effective policies are in place to improve energy efficiency and reduce energy bills.⁵⁰ As a result of a succession of energy efficiency policies, the average SAP (energy performance) rating for the housing stock in England has risen from less than 45 in 1996 to 60 in 2013.⁵¹ In 2014, more than 600,000 insulation measures were installed through the main home energy efficiency policy, the Energy Company Obligation.⁵²

However, increasing the energy efficiency of homes can also have negative consequences in some instances. Various sources of evidence make the link between increasingly air-tight homes and overheating risk (though air-tightness is not the only factor that affects the risk of overheating). For example, the Energy Follow-Up Survey has noted that complaints related to overheating were more likely to occur in homes with SAP ratings higher than 70.⁵³ A 'whole house' approach to design and retrofit for both hot and cold weather would help to address the potential unintended consequences of prioritising energy efficiency over and above other aspects of good design.

4.3.4. Pathogens, air pollution, and UV radiation

Is there a plan?		Well-established warning systems for air pollution and UV radiation exist. Public Health England (PHE) has an ongoing Business Objective to manage and reduce risks of air pollution on health, as well as a programme of research and surveillance for vector-borne pathogens, and the Food Standards Agency has a foodborne diseases strategy. The Advisory Committee on Dangerous Pathogens also advises Government on risks posed to people from pathogens. There is, however, no overarching plan for prioritising the management of endemic and invasive human pathogens and vectors that pose the greatest risk with climate change.
Are actions taking place?		Defra introduced five-day customisable forecasts for air pollution in 2014, alongside health advice and improved guidance and tools for local government. Work has also been undertaken to improve understanding of the risks from waterborne pathogens and a pilot surveillance exercise has been completed by CEFAS to monitor the marine pathogen <i>Vibrio</i> in the environment. Public Health England has made its UK solar radiation data publicly accessible, and is expanding its network of sites in the Mediterranean to provide information for people holidaying there. It continues to expand its surveillance of vectors and is conducting a programme of research on the impacts of environmental change on vectors.

⁵⁰ DECC (2015) *Annual Fuel Poverty Statistics report*, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/429873/Fuel_Poverty_Annual_Report_2015.pdf

⁵¹ See: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/406740/English_Housing_Survey_Headline_Report_2013-14.pdf

⁵² See: CCC (2015) - *Meeting Carbon Budgets - Progress in reducing the UK's emissions: 2015 Report to Parliament*.

⁵³ BRE (2011) for DECC.

<p>Is progress being made in managing vulnerability?</p>	<p>Grey</p>	<p>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.</p> <p>UV radiation levels have increased slightly over the last 20 years. Exposure also depends on how long people spend outdoors and whether they protect their skin, both in the UK and overseas. Vulnerability to air pollution may rise if the number of people with chronic respiratory conditions increases, but it is unclear how the number of people living with chronic respiratory conditions is changing over time. Exposure to vector-borne diseases and other pathogens depends not only on the incidence of pathogens and vectors in the environment, but on the extent to which people are exposed through travelling to places where these pathogens and vectors are prevalent, or coming into contact with food or water that are contaminated.</p>
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Surveillance and warnings systems are especially important where large uncertainties exist over the degree of future risk, and where early warnings will allow the relevant authorities to prepare and respond.

There are large uncertainties related to the potential impacts of climate change on new and emerging pests and pathogens (see also Chapter 5: Agriculture and Forestry), exposure to UV radiation, and air pollution.⁵⁴ These uncertainties relate to both the impact of climate change on exposure, and how the vulnerability of the population may change over time.

Current vulnerability to air pollution is high. Between six and nine million people in the UK suffer from chronic respiratory conditions that make them especially sensitive to air pollution.⁵⁵ However, the effects of climate change on future air pollution patterns is uncertain, as it is dependent on atmospheric processes such as wind direction and changes in the prevalence of static weather patterns ('blocking episodes') rather than just changes in mean temperature.⁵⁶ The trend in the number of people with lifetime chronic respiratory conditions is unclear at present. Population growth and the ageing population are also likely to be increasing the number of people with lifetime respiratory conditions, but there are no long-term data series available.

Similarly, there are large uncertainties over the future degree of risk from UV radiation exposure as a result of climate change. Although exposure may increase somewhat through increases in ambient solar irradiance, the attitudes and behaviour of people to sun exposure will have a large impact on overall risk, and this is very difficult to predict.⁵⁷

It is possible that a changing climate will make certain illnesses such as Lyme Disease and Norovirus more common. Other diseases such as Chikungunya virus and Dengue Fever could be introduced to the UK through infected travellers, but their spread within the UK would also require vectors capable of carrying these pathogens to also be imported. Surveillance for these vectors is ongoing. There are large uncertainties over which pathogens may pose the greatest risk and how exposure to these pathogens may change due to people's behaviour.

⁵⁴ See: <https://www.gov.uk/government/publications/uk-climate-change-risk-assessment-government-report>

⁵⁵ Department of Health (2012) *An outcomes strategy for Chronic Obstructive Pulmonary Disease (COPD) and Asthma in England*, <https://www.gov.uk/government/publications/an-outcomes-strategy-for-people-with-chronic-obstructive-pulmonary-disease-copd-and-asthma-in-england>

⁵⁶ A blocking episode is where a particular weather system (e.g. hot, still weather) remains over the UK for a prolonged period.

⁵⁷ Current measurements also suggest that the solar irradiance distribution across the year is changing, with higher irradiances in the spring when the population have low levels of skin adaptation. It is necessary to distinguish between cumulative exposure to UV in the UK and bursts of more intense exposure, for example while on holiday. These different exposure scenarios have different risk factors.

For example, land management strategies can have a substantial impact on the prevalence of mosquito vectors.⁵⁸ It is not possible to reduce vulnerability to diseases such as Dengue Fever or Chikungunya virus at present as there is no known vaccine, however reducing exposure to the mosquito vectors during travelling, and preventing the local establishment of these mosquitoes, are key strategies for reducing disease incidence. Similarly, Lyme Disease exposure can be changed through avoiding travel into affected areas and covering up skin to avoid tick bites. People can also alter exposure to other illnesses such as Norovirus and *Vibrio*, depending on what they eat.

Because uncertainties exist in relation to future levels of exposure from all of these risks as the climate changes, ongoing surveillance, monitoring and research is a sensible strategy in the short-term.

Good progress has been made through the NAP across a number of areas relating to research, surveillance and warnings.

There are seven actions in the healthy and resilient communities theme on improving surveillance and warning systems for a variety of climate hazards. Progress has been made across a number of areas, including:

- The introduction by the Government of customisable five-day **air pollution forecasts** in 2014.
- The development by CEFAS of an early warning and forecasting tool for **waterborne pathogens** including *Vibrio*, norovirus and Harmful Algal Bloom toxins.
- Public Health England is developing its capability to model and predict potential future changes in **infection incidence** related to climate change, and is also involved in a global horizon scanning programme to identify emerging infectious disease outbreaks and their potential threat to the UK.
- Public Health England, with agreement from Defra, now publishes its **solar radiation** data on the UK-AIR website and has expanded its overseas surveillance through new monitoring sites in Gibraltar and Cyprus (both installed in April 2015).

It is important that evidence continues to be collected on risks from pathogens, air pollution and UV radiation, targeted at better understanding factors that influence exposure, and the future impacts from climate change.

Public Health England should continue to consider its priorities for detection, surveillance and control of pathogens. Priorities should include vector-borne pathogens that are likely to become more common or be introduced as a result of climate change, and Public Health England's work on emergency planning for infectious diseases. Public Health England could create a strategy that prioritises resources on pathogens that are currently thought to pose the greatest risk in future.




To date most of the climate-related research on air pollution has looked at the effects of changing emissions and temperature. Research is needed to assess how changes to climate other than increasing temperatures, such as changing wind patterns and blocking episodes, could impact on air pollution levels. This could form part of Defra's air quality research programme. Public Health England publish an indicator on the fraction of adult mortality attributable to long-term exposure to human-made particulate air pollution. Long-term data on the number of children and adults living with chronic respiratory conditions would also be valuable alongside this indicator. Public Health England should also review its UV radiation data and consider whether any particular regions in England, such as the south-west, should be targeted for future public awareness campaigns.⁵⁹

⁵⁸ Medlock, JM and Vaux, AGC. (2015) Impacts of the creation, expansion and management of English wetlands on mosquito presence and abundance – developing strategies for future disease mitigation. *Parasites and Vectors* 8:142.

⁵⁹ The south-west of England has the highest UV radiation levels in the country and is also where a greater proportion of people report that they spend their leisure time outside compared to the rest of the country.

Public Health England has developed two portable solar UV monitoring stations, which can be deployed where large numbers of people are outdoors during the summer period, and that are capable of supplying real-time UV data on site.

4.3.5. Capability of the health and social care system

Is there a plan?		Under the NHS standard contract, most providers of NHS services have to demonstrate progress towards climate change adaptation in their annual reports and all have to adhere to a set of core standards related to emergency preparedness. There is a non-mandatory standard contract for public health services, but this does not contain provisions for adaptation or preparedness of assets for extreme weather.
Are actions taking place?		Many actions in the NAP are directed at providing improved information and guidance to organisations across all of the risks discussed in this chapter. Examples include Sustainable Development Management Plans (SDMPs), the Strategic Health Asset Planning & Evaluation (SHAPE) tool, Estates Returns Information Collection (ERIC), and the need for NHS managers to report on resilience. Notably, the Sustainable Development Unit has brought together 23 separate organisations involved in the delivery of healthcare to produce a voluntary adaptation report under the Adaptation Reporting Power.
Is progress being made in managing vulnerability?		Whilst it is possible to measure the degree of exposure of health and social care assets to flood risk and overheating to some extent, there is no data currently available on what magnitude of extreme weather is planned for across service providers, and what specific measures are being put in place to mitigate the risks..

Protecting health and social care facilities from severe weather impacts involves not only the physical protection of the asset itself, but also the ability to maintain the service level the facility is designed to deliver.

Weather-related hazards can impact on both individual health and social care assets, and the delivery of services across the system more generally. Assets can be at direct risk from extreme weather. For example, 10 – 14% of emergency service stations, and 6 – 8% of hospitals, care homes and GP surgeries, are located in areas that are potentially susceptible to river and coastal flooding, though the majority are in low or medium risk areas (i.e. with less than a 1-in-30 annual chance of flooding).⁶⁰

As well as the direct risks to infrastructure, service delivery can also be disrupted by extreme weather. For example, during hot and cold weather, ambulance response times increase due to a larger number of call outs. In 2012/13, widespread flooding led to 6,000 more flood-related fire service call outs compared to the previous year.⁶¹

The National Adaptation Programme focusses on improving guidance and information to allow asset managers to consider the risks from climate change.

The NAP has detailed a number of activities to promote information sharing and guidance. For example:

⁶⁰ ASC (2014).

⁶¹ *Ibid.*

- The **NHS Premises Assurance Model (PAM)** is a tool for NHS Trusts to self-report on levels of resilience across a number of areas. From 2014, the PAM includes questions on whether trusts have a sustainable development management plan and have 'safe and compliant systems in relation to resilience, emergency and contingency planning'.
- Approval has been given to include questions on dealing with flooding and overheating in the **Estates Returns Information Collection (ERIC)** from 2015.
- A Department of Health Building Note, **Resilience Planning for the Healthcare Estate**, and its Health Technical Memoranda **Making energy work in healthcare** (HTM 07-02), have been updated to include sections on climate change mitigation and adaptation.
- An '**Under the Weather**' adaptation toolkit has been published. It aims to provide assistance in embedding adaptation into existing strategies and assessments at the local level, which primarily fall under the remit of Health and Well-being Boards (see Chapter 8: Local Government).
- The Environment Agency's Climate Ready service has worked with the Local Government Association to **share key tools and information** on adaptation and promote related events and initiatives through its online knowledge hub.
- The Joseph Rowntree Foundation has launched a '**Climate Just**' website.⁶² This provides free access to detailed spatial data and associated information on social vulnerability to climate-related impacts.

The Sustainable Development Unit (SDU), on behalf of the health sector, has led the production of a report under the Adaptation Reporting Power, bringing together input from 23 separate health and care organisations. The report has provided a baseline level assessment against which the sector's National Cross System Group can monitor progress on improving resilience to climate change impacts over time. The report highlighted, for example, that 57% of NHS providers had a Board-approved adaptation plan. In addition, 60% of the 29 Health and Well-being Boards that responded to a separate survey stated that they had undertaken risk assessments and had local plans in place to address weather-related risks. However, fewer than one-fifth of surveyed Clinical Commissioning Groups set up since 2013 felt their plans were sufficient to adapt the organisation to extreme weather and climate change. Overall there was found to be a lack of information on levels of capability across the sector. The SDU concluded that the health sector was at an early stage of planning for climate change.

While there has been an increase in the amount of activity, information and guidance available across the health sector, it is not yet possible to say how these actions are affecting vulnerability to extreme weather and climate change.




Seventeen of the 42 NAP actions for the healthy and resilient communities theme relate to raising awareness or capacity within health and social care organisations. One quantified measure of outreach has been provided for the 'Under the Weather' toolkit, which has been disseminated to 3,000 people, but similar outputs for other actions have not yet been evaluated.

The ASC's 2014 report and the SDU's 2015 Adaptation Report both noted the absence of a national register of resilience measures for individual assets. This prevents an assessment of how actions are changing vulnerability over time. The SDU's Adaptation Report provides a detailed assessment of current activity and recommends that the sector develop approaches to assess resilience at a national level, including a detailed overview of the risks to buildings and infrastructure and how these are being assessed and managed.

⁶² See: <http://www.climatejust.org.uk/>

In addition, local authorities do not currently have any mandatory duties to report on the measures being taken to protect assets and services against extreme weather in the public health and social care sector. The SDU's Adaptation Report also recommended including social care, community-scale organisations, and the voluntary sector, in future rounds of the Adaptation Reporting Power. Efforts to provide more quantitative data on levels of capability across the health and social care sector through this mechanism would be a valuable addition to the indicators already collected by the ASC. The ASC agrees with the SDU's emphasis to collect and publish more data, and will return to this issue in its next report to update on any progress.

4.3.6. Capability of the emergency planning system

Is there a plan?		The 2004 Civil Contingencies Act sets the framework for action on emergency resilience from national down to local level. Planning at the national level is coordinated through the Cabinet Office's Civil Contingencies Secretariat.
Are actions taking place?		The NAP focusses on the continued, and improved, implementation of a range of processes. These include the National Flood Emergency Framework, Heatwave and Cold Weather Plans, local multi-agency flood plans, National Recovery Guidance, Local Health Resilience Partnerships, the NHS England Emergency Preparedness Framework, the Cabinet Office Strategic National Framework on Community Resilience, and the Government Community Emergency Plan Toolkit.
Is progress being made in managing vulnerability?		<p>Vulnerability to extreme weather is likely to increase in the future, due to the effects of climate change coupled with a growing and ageing population.</p> <p>Despite the large number of initiatives in this area, there remains a lack of information on capabilities and levels of local resilience to extreme weather events. There has been no assessment of the impact on emergency resilience from reducing resources within local government, the police and fire services, and there is no systematic evaluation of local plans. If these gaps are not addressed, there is a risk of vulnerability to weather-related emergencies increasing in the future without the knowledge of responders or the Government.</p>

Emergency planning and response extends beyond the health sector and also involves infrastructure, local government and communities, and the built environment. It represents the 'respond and recover', as opposed to the 'prepare', aspect of adaptation.

The 2004 Civil Contingencies Act provides a framework for emergency planning in England, involving multiple organisations working together across all levels of Government.⁶³ At the local level, emergency responders are organised into Local Resilience Forums (LRFs) which are supported by the Resilience and Emergencies Division in DCLG. At the central Government level, individual departments lead on national planning for risks that are within their remit. These risks are set out in the National Risk Assessment, and its public summary the National Risk Register, both produced by the Cabinet Office. The assessment covers extreme storms, major coastal and river flooding, droughts, heatwaves, cold spells, wildfire, human and animal disease outbreaks, and other non-weather related risks.

Climate change is increasingly being highlighted as a core consideration in guidance on emergency response. For example, the 2015/16 NHS standard contract for NHS funded providers includes

⁶³ ASC (2014).

provisions for both emergency preparedness and for climate change adaptation. The Department of Health produces guidance for asset managers on emergency planning and resilience, which now includes a section on emergency planning and climate change.⁶⁴ The Cabinet Office is also considering the extent to which climate change should be taken into account in the National Risk Assessment, and its links with future iterations of the Climate Change Risk Assessment.

The National Adaptation Programme focusses on the continuation of existing emergency planning processes at the community level, plus the introduction of some new guidance and evidence.

The NAP contains a number of actions related to the continued implementation or enhancement of existing guidance for local responders. A number of positive steps have been achieved, including:

- At the request of Local Resilience Forums, a **Community Preparedness National Group** was set up in 2013 to share good practice and lessons learned from the experience of individual LRFs.
- An information sharing tool, the '**Communities Prepared Hub**', was completed in 2015. This aims to provide Local Resilience Forums with examples of good practice.
- Public Health England organised a series of workshops on how local strategies and assessments, such as **Joint Strategic Needs Assessments and health and well-being strategies**, can better inform action on extreme weather (see Chapter 8: Local Government)..
- The **National Flood Emergency Framework** has been updated to expand its coverage of the health consequences of flooding.
- A new Practice Guide '**Building wildfire resilience into forest management planning**' was published by the Forestry Commission (FC) in 2014 to support the UK Forestry Standard. The Forestry Commission has also updated its internal guidance on contingency plans and response to windstorms, animal and tree pest and disease outbreaks, and wildfires, in England. In addition, it has initiated a project to explore the scope for a common system of wildfire risk analysis and monitoring across the UK, working with the Devolved Administrations. The England and Wales Wildfire Forum (EWWF, composed of 23 stakeholder organisations) also meets regularly to share best practice and consider where guidance and research is most needed.

The actions within the NAP provide an important mechanism to share information and improve good practice. However, there is a lack of quantitative data on required and actual levels of emergency capability across England. This is needed to determine how vulnerability to extreme weather may be changing over time as resourcing levels fluctuate, and to understand where the current system may need to change to cope with future risks from climate change.

The ASC's 2014 report highlighted a lack of evidence in relation to current and required levels of capability in the emergency planning system:

⁶⁴ Department of Health (2014) *Health Building Note 00-07: Emergency Preparedness, Resilience and Response*, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/306367/HBN_00-07-250414.pdf

- **It is not clear what the national level of capability for weather-related hazards should be.** Some quantitative assessments of capability to deal with hazards outlined in the National Risk Assessment do exist. For example, the Environment Agency has undertaken assessments of the minimum number of people that need to be available within the Agency to deal with a major flood incident, and water companies are required to produce plans on the measures needed to deal with a severe drought. However, to date there has been no comprehensive national assessment of the amount and type of resources that should theoretically be available to deal with weather-related hazards. Since 2005, the number of police officers in England has declined by 13,000 (8%) and the number of fire officers by 2,000 (4%).⁶⁵ At the same time, crime levels have fallen by 33% since 2005 and fires by 64% in 2013/14 compared to 2003/4.⁶⁶ Central Government funding for local authorities declined by £6 billion (19.6%) between 2010 and 2014.⁶⁷ The overall effect of these and other changes on emergency preparedness is not known, in part because of the lack of information on what capability levels should be.
- **Actual levels of capability at the local and national level are not assessed in full.** Some information exists on actual levels of capability. For example, there is a national asset register for flood rescue boats funded by Defra. The register is not a complete list; it includes the number of boats, but not whether they may be made available under mutual aid arrangements. DCLG also maintains a register for national assets provided by DCLG to fire services, which is supported by assurance and maintenance arrangements. The NAP contains general actions related to improving local capabilities, such as 'local groups preparing for, responding to and recovering from severe weather events', and 'local resilience forums building community resilience'. However, as these actions are not specific, responsibilities are unclear. Some Local Resilience Forums voluntarily undertake internal and peer reviews of emergency planning processes, though these do not currently quantify what resources are available.

RECOMMENDATION 18: Cabinet Office should, before the ASC's next report in 2017, undertake a quantitative assessment of the capability of the national emergency planning system to manage extreme weather events, and in light of the findings, publish a summary outlining where further action may be needed.




RECOMMENDATION 19: DCLG should work with Local Resilience Forums to instigate a system that quantitatively assesses local capabilities to respond to extreme weather events, with the results to be made available in time for the ASC's next progress report in 2017.

⁶⁵ ASC (2014).

⁶⁶ DCLG (2014) *Crime Statistics ending December 2014*, <http://www.ons.gov.uk/ons/rel/crime-stats/crime-statistics/year-ending-december-2014/sty-crime-statistics.html>; DCLG (2013) *Fire Statistics Monitor: England April 2013 – March 2014*, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/325696/Fire_Statistics_Monitor_April_2013_to_March_2014_final__3_.pdf

⁶⁷ Audit Commission (2013) *Tough Times 2013: Councils' responses to financial challenges from 2010/11 to 2013/14*, <http://www.audit-commission.gov.uk/wp-content/uploads/2013/11/Tough-Times-2013-Councils-Responses-to-Financial-Challenges-w1.pdf>

4.3.7. Capacity of people and communities to recover from flooding

Is there a plan?		Plans for recovery after a major event are prepared at the local level by Local Resilience Forums, rather than as a statutory requirement of the Civil Contingencies Act. There is guidance on the health impacts from flooding within the National Flood Emergency Framework, but no specific plan is in place.
Are actions taking place?		The NAP includes an action for Local Resilience Forums to take account of national recovery guidance. Updated information leaflets on addressing the health impacts of flooding have been published, and guidance is also set out in the National Flood Emergency Framework. A new cohort study to provide evidence on the long-term health impacts of flooding has commenced, with 1,800 participants confirmed so far. Public Health England has also published an evidence report on surveillance of the health impacts of flooding under the EU-funded PHASE programme.
Is progress being made in managing vulnerability?		The number of people and properties exposed to a high risk of flooding is expected to increase across the country (see Chapter 2 : Built Environment) even if all worthwhile flood defences are built in the coming decades. However, there is a paucity of evidence on the impacts on individual health and well-being arising from flood events, beyond simple metrics like anxiety scores in general health questionnaires. It is therefore not currently possible to assess whether the steps being taken mean people are able to recover from flooding more quickly.

Recovery from flooding refers to the long-term process of rebuilding, restoring and rehabilitating communities after a flood event. Impacts of flooding on mental health, social and economic well-being last long after physical repairs to buildings and infrastructure have been made.

Recovery from flooding entails the processes that take place over months and years to repair the damage caused by the event, including impacts on the health and well-being of those affected. Recovery is not included in the statutory framework of the Civil Contingencies Act. Rather, responsibility for recovering from floods sits with local health and social care providers and local authorities. Guidance for local responders is issued by central Government.

The NAP focusses on improving the evidence base, and sharing information, on the health impacts of flooding.

The mental health consequences from flooding were amongst the largest impacts highlighted by the 2012 Climate Change Risk Assessment. However, there is very little data that tracks people's actual experience; what the specific impacts are, how long they last, and how best they are alleviated. Some event-based data is available. For example, one study found that 12% of the flooded population in Hull after the 2007 floods were still in temporary accommodation 12 months after the event.⁶⁸ DCLG have collected similar information for the 2013/14 floods from local councils, but this is not published.

⁶⁸ Milojevic et al. (2011) Long-term effects of flooding on mortality in England and Wales, 1994-2005: controlled interrupted time-series analysis, *Environmental Health* 10:11.; Paranjothy et al. (2011) Psychosocial impact of the summer 2007 floods in England, *BMC Public Health* 11:145.

Public Health England published a review in 2014 on how routine health data can be used to undertake surveillance of the health impacts of flooding. This highlighted the need for better indicators for mental health impacts from flooding, going beyond metrics such as anxiety scores in questionnaires.⁶⁹ Following on from this, Public Health England is leading a new cohort study to better understand the long-term impacts of flooding on health, and will publish several reports over the next ten years.

The Department of Health, Public Health England and the Environment Agency have also collaborated to produce new guidance and information for responders on recovery from flooding, including the health impacts of flooding.

Greater understanding is needed regarding the scale of impact from flooding on people's health, and the ability of affected communities to recover.

A lack of public awareness of the personal risks from flooding coupled with more people exposed to high levels of flood risk in the future will mean that the health and well-being impacts of flooding are likely to rise. However, there is insufficient evidence to track how vulnerability may be changing over time. Metrics such as days off work and school, time taken to return to homes, and resources available at local authority level, would be a valuable addition to the evidence base.

RECOMMENDATION 20: Local authorities should routinely collect and publish data on flood recovery, including the length of time occupants have to wait until they are able to return to their homes after a flood event. DCLG should review the capacity of local authorities to support people physically and mentally in the aftermath of a flood, and publish its findings before the ASC's next report in 2017.

4.4 Conclusions on NAP objectives and actions

The table below summarises progress as far as can be established against the objectives listed within the NAP for the Healthy and Resilient Communities theme.

Of the 42 actions in the Healthy and Resilient Communities chapter of the NAP:

- 7 (17%) are complete;
- 31 (74%) are on-track; and
- 3 (7%) have been revised, delayed or dropped.

An update was not provided to the ASC on the remaining one action.

Six actions are time-bound with a defined end date, and the remaining 36 are classed as on-going or do not have an end date.

Progress towards the objectives contained within the NAP cannot be measured quantitatively. The table below provides a brief assessment of the extent to which there is evidence of progress.

⁶⁹ See: <https://www.gov.uk/government/collections/flooding-health-guidance-and-advice>

Table 4.1: NAP objectives and a summary of progress for the healthy and resilient communities theme

NAP objective	Commentary on progress
<p>Objective 11: To reduce the risk of death and illness associated with severe weather events and climate change and increase preparedness and resilience to the impacts on public health.</p>	<p>There are 21 actions for this objective, including actions to increase awareness, address evidence gaps, and increase resilience to current extremes.</p> <p>All but two actions are on-track or complete. These two actions relate to research into ground level ozone and aeroallergens, which have been revised or delayed.</p> <p>Not enough time has passed to detect any changes in mortality and morbidity from extreme weather as a result of the actions taken. In any case, demonstrating the impacts of these actions on the risk of death and illness is extremely difficult. The ASC is instead focussing on how vulnerability and exposure to severe weather is changing over time. There is currently also a lack of data to show whether vulnerability has changed materially since the start of the NAP period as a result of the actions taken, but this data could be collected in future.</p>
<p>Objective 12: To promote climate resilience within the NHS, public health and social care system to ensure continuity of services and resilient assets/estates, including the ability to deal with the increased demand for services associated with severe weather-related events.</p>	<p>There are eight actions for this objective, mostly relating to increasing awareness amongst health and social care organisations.</p> <p>All of the actions are on-track.</p> <p>The actions listed have been successful at promoting climate resilience in the NHS, including through the work of the Sustainable Development Unit (although the SDU's actions are listed under Objective 11). For example, 36% of NHS organisations have produced sustainable development management plans. Positive effects on the public health and social care system more generally are less clear due to a lack of evaluation by organisations.</p>
<p>Objective 13: To minimise the impacts of climate change on vulnerable groups in society by strengthening their resilience to better prepare for, respond to and recover from future climate risk.</p>	<p>There are three actions for this objective, all relating to increasing awareness.</p> <p>All are complete or on-track.</p> <p>There is no available evidence to demonstrate that the resilience of target groups has been strengthened through the NAP actions. The actions relate to building capacity rather than directly addressing vulnerabilities.</p>
<p>Objective 14: To promote and strengthen community resilience to severe weather related events linked to climate change (preparation, response and recovery), and the climate resilience of the emergency services and other Category 1 and 2 Responders of the Local Resilience Forums (LRFs).</p>	<p>There are 11 actions for this objective, mostly relating to increasing awareness amongst emergency planners and responders.</p> <p>All actions are complete or on-track, apart from one relating to wildfire management that has been superseded by a separate project.</p> <p>There have been some good examples of local action to improve resilience to flooding in particular. However, the actual and required level of capability of the national emergency planning system remains unknown, and without understanding this it is not possible to measure the extent to which vulnerability is being managed.</p>



Chapter 5: Agriculture and forestry

- 5.1 Climate change and the agriculture and forestry sectors
- 5.2 Risks to agriculture and forestry from climate change
- 5.3 Progress being made
- 5.4 Conclusions on NAP objectives and actions



Key messages

Climate change presents potential opportunities for agriculture and forestry from faster growth of crops and trees and extended growing seasons. But climate change also poses challenges that could limit these potential opportunities. Projected rises in temperatures and reduced summer rainfall will increase the need for irrigation of crops and water for livestock. Drier soils are more likely to erode, losing organic content and releasing carbon dioxide to the atmosphere. Flooding of farmland in some areas could become more frequent and new pests and diseases could pose additional risks to trees, crops and livestock.

Although some progress is being made with reducing demand for water and ensuring the climatic suitability of trees planted in the public forest estate, many aspects of the agriculture and forestry sectors are ill-prepared for a changing climate. Reforms to the water abstraction licencing regime are long overdue, farming practices in some areas are exacerbating flood risk, high-grade productive soils are being lost to erosion, and incidents of pests and diseases are increasing. Despite these trends, there has been a decline in investment into research and development of new approaches and technologies that are needed to boost the resilience of agriculture and forestry in England.

Overview of progress

Adaptation priorities	Is there a plan?	Are actions taking place?	Is progress being made in managing vulnerability?
1. Water demand by agriculture	Amber	Amber	Amber
2. Flooding of agricultural land	Amber	Green	Amber
3. Fertility of agricultural soils	Amber	Amber	Red
4. Climatic suitability of tree species	Green	Green	Green
5. Prevalence of new and existing pests and diseases	Green	Green	Grey
6. Innovation and knowledge transfer	Green	Amber	Amber

Note: The criteria for Red, Amber, Green or Grey status for each of the three questions are as follows:

Is there a Plan? Green - where needed, plans or policies are in place that fully address the adaptation priority in the context of climate change. Amber - plans or policies are in place that partially address the adaptation priority. Red - no specific policies or plans are in place.

Are actions taking place? Green – all relevant NAP actions are complete or on-track, other relevant actions or commitments are being implemented. Amber – not all relevant NAP actions are on-track, partial delivery of other actions or commitments. Red – NAP actions mostly delayed or dropped, other relevant actions behind schedule.

Is progress being made in managing vulnerability? Green – trends in vulnerability are reducing or not increasing; there is high uptake of low-regret adaptation measures; long-term decisions are accounting for the future climate. Amber – some trends in vulnerability are increasing; scope to increase low-regret adaptation, decisions partially or inconsistently account for the future climate. Red – most trends in vulnerability increasing; minimal or zero uptake of low-regret adaptation; long-term decisions not taking the future climate into account.

Grey – insufficient evidence available to make a judgement.

See Chapter 1 for a full description of the approach.

Summary of progress

There are some positive signs of progress being made by the agriculture and forestry sectors to prepare for climate change, supported by policies referred to in the National Adaptation Programme (NAP):

- **Water demand by agriculture is falling.** Water abstraction for irrigation has been on a downward trend since the early 1990s. This is partly due to some improvement in water efficiency, but also because the total area of cropped land has declined and less water-intensive crop types are being grown.
- **The Government has set ambitious goals for the management of soils and there is some evidence soil erosion risk is reducing.** The Government has committed to ensuring all soils are managed sustainably by 2030. A five-year research programme to inform the policies needed to meet this goal is drawing to a close. Changes in crop type are reducing the risks of soil erosion in some areas. The area under high erosion risk crops such as potato and sugar beet has fallen while there has been an increase in the area under low erosion risk crops such as oil seed rape. However, this has been partly offset by the five-fold increase in the area of land under maize between 1988 and 2010, which is potentially increasing soil erosion risk in some parts of the country, particularly the south west of England.
- **Decisions on tree planting on the public forest estate are taking account of climate change. More private forests are coming under active management.** Between 2005/06 and 2013/14 the number of different conifer species planted on the public forest estate increased from 11 to 25, improving the diversity of the overall stock. Planting locations have been changed to reflect the long-term suitability of tree species for particular locations, although there is still a risk that between 5% and 40% of oak, pine, spruce and beech planted in the past 40 years may be in areas that become climatically unsuitable for those species by the 2050s. Progress is on-track to meet the Forestry Commission's target of 66% of the area of private forests being under active management by 2018.
- **The Government has launched an Agri-Tech Strategy.** This has committed £160 million to support the development of agricultural technologies, innovation and sustainability. It is too early to assess the impact of the strategy, but it should be an important lever for delivering greater dissemination of research and technology to farmers.

However, there are a number of areas where vulnerability to climate change is likely to be increasing:

- **There is no clear relationship between water availability and the cost of water to farmers.** Without timely reform of the abstraction regime, farmers may not be sufficiently incentivised to reduce water use if significant supply-demand deficits materialise in the future.
- **Some forms of farming practices are exacerbating flood risk.** Although the area of agricultural land protected by flood defences is increasing, some forms of farming practices are potentially exacerbating flood risk, increasing the need for dredging and watercourse management downstream.

Key messages

- **Soils are being degraded in some areas due to land management practices.** Soil organic carbon levels deteriorated nationally in arable soils between the 1970s and early 2000s. The on-going loss of lowland peat soils is putting at risk some of the most productive land and largest carbon stores in England. Today, only around 16% of the peat stock in the East Anglian Fens recorded in 1850 remains and much of this will be irreversibly degraded in the next few decades if current land use practices continue. As well as impacting on food production, this scale of carbon loss will also have implications for meeting the UK's carbon budgets.
- **There has been a substantial increase in the incidence and establishment of invasive non-native species since the 1990s.** This is primarily due to socioeconomic factors, particularly global trade. Climate change will alter the conditions under which different invasive non-native species may thrive. However, the specific risks are not well understood.
- **Investment in research and development, and agricultural productivity benchmarks, are in decline.** Between 1987 and 2009 the amount spent on research and development (R&D) for agriculture fell by around a fifth in real terms. This has largely been driven by falls in public sector spending over this period. Agricultural productivity for the UK has also risen more slowly relative to other European countries and the United States.

Recommendations for further progress

- **RECOMMENDATION 21:** Defra should bring forward its planned review of water efficiency measures on farms to the summer of 2016, in line with the initial plans presented in the National Adaptation Programme.
- **RECOMMENDATION 22:** Defra, in collaboration with the Environment Agency and others such as the National Farmers Union, the Country Land and Business Association, and the Association of Drainage Authorities, should pilot integrated approaches to managing the risk of flooding to agricultural land. Approaches should incorporate catchment management, best practice farming approaches, and appropriate land drainage and flood defences. This should be completed in time to inform wider dissemination of the lessons as part of the next NAP in 2018.
- **RECOMMENDATION 23:** Defra should take action to deliver its policy aspiration for all soils to be sustainably managed by 2030, publishing an action plan within a year of this report to describe how the goal will be achieved. The action plan should include proposals for establishing a scheme to monitor the uptake of soil conservation measures, with enforcement where soils are not being appropriately managed. The action plan should include specific proposals to reverse the on-going loss of lowland peat soils, and be developed in partnership with the farming sector.
- **RECOMMENDATION 24:** Defra should use the information contained within the UK Plant Health Risk Register to publish aggregate metrics that enable the overall risk from pests and diseases to be monitored over time. This should be completed in time to inform the ASC's next progress report in 2017.
- **RECOMMENDATION 25:** Defra should publish an initial evaluation of the impact of the Agri-Tech Strategy in time to inform the next NAP in 2018.

Vision: “Profitable and productive agriculture and forestry sectors that take the opportunities from climate change, are resilient to its threats and contribute to the resilience of the natural environment by helping to maintain ecosystem services and protect and enhance biodiversity.”

HM Government, 2013 National Adaptation Programme

5.1 Climate change and the agriculture and forestry sectors

Agriculture and forestry are important economic industries. Farming realises value from the land from growing crops and rearing livestock. This is predominantly for food, but some land is also used to grow dedicated energy crops.¹ Forestry is considered in this chapter as primarily for timber production. The wider ecosystem services provided by agriculture and woodlands are covered in the Natural Environment chapter (Chapter 6).

The agriculture and forestry sectors are inherently vulnerable to climate change, and associated changes in weather, due to their dependence on weather conditions. In many respects, agriculture has a high adaptive capacity due to the sector’s responsiveness to market signals and short lead times in crop and land management choices. There are, however, aspects of the sector that require longer-term planning, such as investment in buildings and machinery, and research. The forestry sector faces the challenge of long rotation periods, requiring a changing climate to be embedded in long-term decisions on the type and location of tree planting. Short-term planning horizons and tight margins are barriers to optimal adaptation in these areas. Both sectors are also heavily influenced by the European Union’s Common Agricultural Policy (Box 5.1).

There is the potential for both the agriculture and forestry sectors to benefit from the changing climate, with longer growing seasons and some marginal land becoming viable. However, if the farming sector in particular is to take advantage of these opportunities it needs to move towards more sustainable use of key resources, most notably soil and water.

Box 5.1: Adaptation and the European Union’s Common Agricultural Policy

The European Union’s Common Agricultural Policy (CAP) provides payments to farmers to promote environmental outcomes and to improve productivity. The majority of the funds are spent under ‘Pillar I’ (£11.5 billion in England between 2014 and 2020), with a common payment framework across the European Union. Pillar I involves direct payments based on area of land and use of practices that meet certain environmental standards (‘greening’ and ‘cross-compliance’), with additional payments to young farmers entering the sector. There is more scope for national variation of policies under ‘Pillar II’ (£3.5 billion in England between 2014 and 2020). This funds the Rural Development Programme, including investment in schemes that protect the environment, improve productivity in the farming and forestry sectors, and support the rural economy.

The CAP has the potential to provide stronger incentives for adaptation and build resilience to climate change. All of the adaptation priorities highlighted in this chapter are affected by CAP policies. Details are included in the relevant sections below. It was beyond the scope of this report to provide a full review of CAP and its impact on adaptation. It will be important for the Government to consider the links between CAP incentives and adaptation, particularly in discussions about the design of the next round of CAP from 2016.

Source: Information publicly available on www.gov.uk.

¹ See CCC (2011) *Bioenergy Review*, http://archive.theccc.org.uk/aws2/Bioenergy/1463%20CCC_Bioenergy%20review_bookmarked_1.pdf

5.2 Risks to agriculture and forestry from climate change

The 2012 Climate Change Risk Assessment identified a range of risks and opportunities to UK agriculture and forestry.²

The CCRA highlighted that there are likely to be opportunities to grow new food and non-food crops and for increased land productivity. However, the ability to take advantage of any potential opportunities will be dependent on the resilience of agriculture and forestry to projected increases in climate-related risks, including from water scarcity, flooding, loss of soil carbon, pests and diseases and heat stress.

Water availability will be an important determinant of whether farming will benefit from the longer growing seasons projected with climate change. The agriculture sector obtains water from the public water supply and by direct abstraction from watercourses and aquifers. Around three-quarters of the direct abstraction is used for irrigation, the demand for which is likely to increase as summers become hotter and drier and rain-fed agriculture becomes less viable. Water use for irrigation is currently concentrated in the south and east of England in areas that are either already water stressed or likely to become so.

Climate projections suggest that winter rainfall will increase in volume and intensity, increasing the likelihood of flooding from rivers and surface water. Around 200,000 hectares of agricultural land has a 1-in-10 or greater annual chance of river or coastal flooding, making up 2.5% of the total area of agricultural land in England. This is projected to increase to 500,000 hectares (6.3% of the total area) by the 2080s.³ Summer rainfall is likely to fall in heavier bursts, with one recent study suggesting convective storms could increase by as much as a factor of five by 2100 under a high emissions scenario.⁴ River flooding brings benefits as well as costs to agricultural land. In the short-term crop growth is reduced, ploughing is more difficult, and livestock cannot be grazed without damaging the soil. But once water levels have fallen there can be longer-term gains in fertility. As well as river flooding, the risk to agricultural land from coastal change is likely to increase in some areas with sea level rise. However, this is a relatively localised risk, with less than 0.1% of agricultural land in England projected to be lost by the 2080s.⁵

Soil will become more susceptible to water erosion with expected increases in rainfall volume and intensity. Wind erosion will also be more likely if soils become more arid during hotter, drier summers. Due to higher temperatures and reduced soil moisture, soil is also likely to suffer decreases in organic matter. Organic matter is vital for productivity and biodiversity due to the retention of nutrients and water. Soil degradation decreases agricultural productivity and increases the cost of water treatment and sediment removal from rivers by dredging. Soil takes centuries to form naturally, so degradation is effectively irreversible. An estimated 10 billion tonnes of carbon are stored in UK soils, 50 times the carbon stored in UK vegetation.⁶

Though difficult to quantify, rising temperatures are likely to make the UK more suitable for some pathogens and diseases that are not currently a threat. Climate change could also increase the damage caused by endemic diseases through, for example, decreasing water quality. Heat stress may also become a more significant risk, particularly for livestock. Current vulnerability is low for cattle, but poultry and pigs can suffer from heat stress during transport.

² HM Government (2012) *UK Climate Change Risk Assessment: Government Report*, www.gov.uk/government/publications/uk-climate-change-risk-assessment-government-report

³ Knox, J.W. et al. (2012) *Climate change risk assessment for the agriculture sector*, http://randd.defra.gov.uk/Document.aspx?Document=10070_CCRafortheAgricultureSector16July2012.pdf

⁴ Kendon, E.J. et al. (2014) Heavier summer downpours with climate change revealed by weather forecast resolution model. *Nature Climate Change*, 4, 570-576.

⁵ Knox, J.W. et al. (2012).

⁶ Defra (2009) *Safeguarding our soils: A strategy for England*, <https://www.gov.uk/government/publications/safeguarding-our-soils-a-strategy-for-england>

However, measures to reduce overheating in transport and housing can be implemented on relatively short timescales (less than 10 years).⁷

Changes in temperature, soil moisture, and wind, pose a risk to forestry production. Trees planted in historically suitable areas may be at risk as habitable ranges change over time. Planting location decisions will be further complicated by uncertainty over how the climatically suitable ranges for different species will change.

In response to these risks, the Government's National Adaptation Programme (NAP) sets four objectives for the agriculture and forestry theme.⁸

The objectives were identified following consultation across a wide range of stakeholders with expertise in the agriculture and forestry sectors, including industry representatives, statutory bodies, and environmental charities.

- **Objective 15:** To increase the resilience of agriculture by effectively managing the impact of volatility in the occurrence and severity of rainfall events on water availability, flooding, soil erosion and pollution due to run-off.
- **Objective 16:** To increase the resilience of the forestry sector by increasing the level of management in England's woodlands and the uptake of adaptation good practice in woodland creation and restocking.
- **Objective 17:** To increase resilience to pests and disease to help protect biodiversity, maintain agricultural and forestry productivity and protect the UK's ability to export products.
- **Objective 18:** To embed climate change adaptation into agriculture, horticulture and forestry research programmes, in order to improve knowledge of likely climate impacts and contribute to the development and uptake of climate resilient crops, tree and livestock species as well as relevant technologies.

The NAP objectives describe important high-level principles and processes for adaptation in the agriculture and forestry sectors. We have reviewed progress by the actions in the NAP against each objective in Section 5.4 below.

As noted in Chapter 1, the NAP objectives tend to describe processes rather than outcomes and do not always state goals against which substantive progress can be measured. Even where the 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 NAP themes. The progress being made in respect of each of these adaptation priorities is reviewed in Section 5.3.

Figure 5.1 summarises the climate hazards, contextual factors and adaptation priorities that are relevant to the agriculture and forestry theme, together with a summary of the actions listed in the NAP.

⁷ ASC (2013) *Managing the land in a changing climate*, <http://www.theccc.org.uk/publication/managing-the-land-in-a-changing-climate/>

⁸ HM Government (2013) *National Adaptation Programme, making the country resilient to a changing climate*, www.gov.uk/government/publications/adapting-to-climate-change-national-adaptation-programme




Figure 5.1: Climate hazards, contextual factors and adaptation priorities for the agriculture and forestry theme

Climate hazards	Contextual factors	Adaptation priorities	Relevant NAP actions
<p>Reduced water levels/flows</p> <p>Drought</p> <p>Heavier rainfall</p> <p>Sea level rise and flooding</p> <p>Higher average and extreme temperatures</p>	<p>Population growth</p> <p>Economic growth</p> <p>Consumer preferences</p> <p>Land-use change</p> <p>Influence of European Union policies</p>	Water demand by agriculture	<ul style="list-style-type: none"> Defra to consult on abstraction licensing reform, and consider the need for water efficiency policies in advance of new legislation
		Flooding of agricultural land	<ul style="list-style-type: none"> Continue Catchment Sensitive Farming project Defra to identify good drainage practice and explore role of Internal Drainage Boards
		Fertility of agricultural soils	<ul style="list-style-type: none"> Defra to conduct the Soil Protection Review All soils will be managed sustainably and degradation threats tackled successfully by 2030 as outlined in the Natural Environment White Paper. Four-year research programme to look at effects of soil degradation on soil function BBSRC/NERC action on soils research programme BBSRC collaboration in EU Adaptation ERANET+
		Climatic suitability of tree species	<ul style="list-style-type: none"> EWTP to publish a Climate Change Action Plan Implementation of the Forestry Commission England Outline Adaptation Plan Promotion and development of guidance to underpin the UK Forestry Standard Forests and Climate Change Guidelines Publication of a UK Science and Innovation Strategy for British Forestry
		Prevalence of new and existing pests and diseases	<ul style="list-style-type: none"> Implementation of the research and evidence theme of the Tree Health and Plant Biosecurity Action Plan Defra to commission independent task force to consider ways to prevent and manage new pests and diseases entering the country Review whether plant health protection programmes integrate climate risk Defra to decide whether Fera prepares a voluntary adaptation report Tree Health and Plant Biosecurity Research Initiative to research resilience of UK trees, woodlands and associated biodiversity in a changing climate Improve evidence base of climate impacts on animal disease Review Invasive Non-Native Species Framework Strategy for Great Britain
		Innovation and knowledge transfer	<ul style="list-style-type: none"> EA Climate Ready to develop a network of farm demonstration activity EA Climate Ready to develop, promote and embed adaptation good practice, common messages, tools and guidance Defra to embed adaptation into the Rural Development Programme for England BIS/Defra commitment to innovation and development of new technology

5.3 Progress being made

This section evaluates the extent to which the actions and policies in the NAP and elsewhere are addressing the identified climate risks, following the method described in Chapter 1. The following section, Section 5.4, provides an overall summary of progress against the objectives set in the NAP. Further details and the underlying evidence supporting the analysis for each of these factors can be found in an annex to this report available on the CCC's website.

5.3.1. Water demand by agriculture

Is there a plan?	 Amber	Reforming the water abstraction licencing regime will be the primary means by which farmers and other water abstractors will be encouraged to use water more sustainably. Reforms will be introduced in the early 2020s at the earliest. In the meantime the Environment Agency is reviewing and revising existing licenses that pose a potential risk to protected wildlife sites.
Are actions taking place?	 Amber	Funding is available through the Rural Development Programme for England for capital projects for on-farm storage reservoirs. Defra published a summary of an early consultation on reforming the abstraction licencing regime in July 2014. However, a review of the need for short-term water efficiency measures to bridge the gap to implementation of abstraction licencing reform in the 2020s has been delayed from 2015 to 2018.
Is progress being made in managing vulnerability?	 Amber	The latest evidence suggests abstraction and irrigation demand for agriculture have been falling since 1990. The number of on-farm reservoirs is increasing, albeit at a relatively slow pace. However, there are large uncertainties in recent trends in water use and projections of future supply-demand deficits. There is also no clear relationship between water availability and the cost of water to farmers. Without timely reform of the abstraction regime, farmers may not be sufficiently incentivised to reduce water use if supply deficits do materialise.

Water is a vital input for the production of crops and the rearing of livestock. The concentration of agricultural production in areas that are already water-stressed means the sector is at particular risk of water scarcity both now and in the future.

The agriculture sector uses water to irrigate crops, as drinking water for livestock, and for washing down buildings and machinery. Between 55 - 60% of the total water used comes from the public water supply. The remainder is abstracted directly from surface water bodies, such as rivers, lakes and streams, and groundwater sites. Between 2000 and 2011, around three-quarters (89 billion litres per year on average) of water directly abstracted by the agriculture sector was used for spray irrigation, with the remaining quarter (30 billion litres per year on average) used for other agricultural purposes.⁹

The majority of cropland in England is located in the south and east of the country, in areas already facing the highest levels of water stress. These areas are also likely to experience the largest reductions in rainfall due to climate change, and the biggest increase in demand due to population growth. Livestock production on the other hand is concentrated more in areas where water is less constrained, such as in the south west of England and the uplands.¹⁰

There are large uncertainties around the future demand and supply of water for agriculture. Previous analysis by the ASC suggested climate change and population growth could create an imbalance between supply and demand for irrigation of between 45 to 115 billion litres in a dry year within the

⁹ ASC (2013).

¹⁰ *Ibid.*

next 10 to 20 years.¹¹ The upper end of this range is equivalent to the total volume of water currently abstracted for agriculture. Ensuring water is managed efficiently by the sector is therefore important for safeguarding the security of supply.

There are existing policies in place that govern water use by agriculture and encourage efficient water management.

- Water directly abstracted from surface water and groundwater sites by the sector is covered by the abstraction licensing regime. Some spray irrigators face a two-part tariff, with part of the charges being dependent on the amount of water abstracted by the irrigator. Defra consulted on reforming the abstraction regime in December 2013 and plans to introduce new legislation in this Parliament to encourage abstractors such as farmers to use water more efficiently.
- The Environment Agency's Restoring Sustainable Abstraction programme is investigating licences that are causing particular problems for protected habitats (such as Sites of Special Scientific Interest) or other localised issues (see Chapter 6: Natural environment). Licences for agricultural abstractions account for 162 of the 484 licences identified for review. Just over a half of the agricultural licences have been reviewed, and most of these have been changed or revoked to help restore sustainable abstraction levels.
- The Common Agricultural Policy requires farmers to implement water and soil management measures as part of cross-compliance mechanisms. These set a series of environmental standards that must be met for farmers to qualify for direct payments under Pillar I. Funding is also available for on-farm reservoirs under the Rural Development Programme for England.
- The Farming Advisory Service (FAS), funded by Defra, provides technical and business advice to farmers on water use and quality, to help farmers meet requirements in the Water Framework Directive and to receive payments under the CAP. The Environment Agency's Climate Ready service also provides advice to farmers and has run a series of workshops on resilience to climate change with the FAS.

There are large uncertainties in the long-term trends in water demand for agriculture. Current evidence suggests water use by the sector has been falling in recent years, after allowing for annual weather variation.

Between 1970 and 1990 both licensed abstraction and actual abstraction for agriculture increased. After accounting for differences in annual weather patterns, modelled demand in a dry year also increased. Since 1990 these trends appear to have reversed. One study that assessed how demand may be changing when annual rainfall levels are accounted for found that demand in a dry year declined by an average of 1.4% per year between 1990 and 2010.¹²

The recent fall in water demand for crop irrigation could be the result of a number of drivers. The cropped area of potatoes fell by around a third between 1990 and 2010. Potatoes are one of the most water-intensive crops, accounting for the majority of water used for irrigation. The cropped area of soft fruits, vegetables, and cereals has also fallen since 1990. Improvements in irrigation efficiency for potatoes may also have been a contributory factor. Results from the Defra irrigation survey show the depth of water applied for potatoes (volume per unit area) has fallen.¹³

¹¹ *Ibid.* This analysis was based on future demand scenarios published by the Environment Agency and supply scenarios based on the 2009 UK Climate Projections.

¹² Weatherhead, K. et al. (2013) *Assessing future water demand for agricultural irrigation in England and Wales – an updated analysis*. Supporting paper for Living with Environmental Change (LWEC) water climate change report card.

¹³ Cranfield University (2015) for the ASC *Research to develop the evidence base on soil erosion and water use in agriculture*.

Trends in water use for livestock are less certain as there are no nationally published statistics. However, estimates can be made by multiplying the water requirement for each livestock category in each year by the number of livestock of that category in England. This suggests water use for livestock fell by around one-third from 1984 to 2009 and has since stabilised. This has primarily been driven by a decline in cattle herd sizes, which account for the majority of water demand for livestock.¹⁴

There are low-regret adaptation options available to farmers that would increase farm resilience to future water shortages. Having a pricing framework for water that is more responsive to changes in its scarcity over time should provide a stronger incentive for these options to be more widely adopted.

- Irrigation scheduling trials have produced water savings of around 30% for soft fruit without compromising growth.¹⁵ If this scale of benefit is transferable to other crops and can be widely adopted it could provide substantial water savings without compromising marketable yields.
- On average, around half of potatoes grown in Great Britain are irrigated.¹⁶ A main driver for this is quality assurance (scab control) to improve size, shape and skin finish. The demand for scab-free potatoes is largely aesthetic and driven by consumer and retailer demand. Increasing the market acceptability of potatoes of lower aesthetic quality, or finding alternative means to reduce scab control with lower water use, could increase water efficiency markedly for this crop.¹⁷
- On-farm reservoirs are an important adaptation measure alongside improving water efficiency, as they provide an additional water source for irrigation at times when there is less water available from rivers and groundwater sources. Across England, on-farm reservoirs provided around 21 billion litres of water in 2009/10 (around 20% of the total annual volume of water used for irrigation).¹⁸ However, farmers face high up-front costs when building on-farm storage and these costs are not balanced out by cheaper abstraction charges in winter. Barriers may also exist in the land use planning system.

Water pricing that better reflects its scarcity will provide stronger incentives for action. At present, there is no clear relationship between water availability and the cost of water to farmers at the regional level.¹⁹ It is important the new abstraction regime establishes a pricing framework that is more responsive to water scarcity, while taking into account the needs of the natural environment, in order to incentivise the measures considered above.

RECOMMENDATION 21: Defra should bring forward its planned review of water efficiency measures on farms to the summer of 2016, in line with the initial plans presented in the National Adaptation Programme.

¹⁴ Cranfield University (2015) for the ASC *Research to develop the evidence base on soil erosion and water use in agriculture*.

¹⁵ *Ibid.*




¹⁶ Daccache, A. et al. (2011) Impacts of climate change on irrigated potato production in England. *Agriculture and Forest Meteorology*, 151 (2011), 1641-53.

¹⁷ Potato Council (2011) *Common scab. Cost benefit analysis CB03*, http://www.potato.org.uk/sites/default/files/publication_upload/Cost%20Benefit%20Analysis%20CB03%20-%20Common%20scab.pdf

¹⁸ Morris, J. et al. (2013) The sustainability of irrigation in England and the impact of water pricing and regulation policy options. *Advances in Water Supply Management*. The storage volume is calculated from the highest amount of water which was abstracted in winter to fill reservoirs, which was around 21 billion litres in 2009/10. The total capacity is almost certainly larger than this, as not all reservoirs would have been empty and completely filled during the winter of 2009/10. There may also be reservoirs which have been built but are not being used at all at present.

¹⁹ ASC (2013).

5.3.2. Flooding of agricultural land

Is there a plan?		Protecting agricultural land is within the National Flood and Coastal Risk Management Strategy for England. Catchment Flood Management Plans, which are used to inform decisions on flood risk management, take into consideration the effects of land management practices and climate change on flood risk. Water Level Management Plans are prepared by the Environment Agency, Internal Drainage Boards and certain local authorities that exercise drainage powers. However, plans to manage flooding of agricultural land and the effects of land management practices on flood risk are fragmented.
Are actions taking place?		The level of protection of agricultural land has increased as part of the national programme for flood and coastal defence overseen by the Environment Agency. For example, 74,000 hectares of farmland received an improved level of flood protection in 2011/12 alone. Natural flood management pilots are building the evidence base for how land management can reduce peak river flows and downstream flood risk. A review of drainage infrastructure has been completed although Defra has yet to publish the results.
Is progress being made in managing vulnerability?		While the level of protection of agricultural land is increasing, in some areas farming practices are continuing to cause soil erosion and downstream flood risk.

Around half the area of agricultural land in England is at risk from waterlogging or flooding, with lost output a direct cost to farmers. However, agricultural practices can also exacerbate flood risk.

Around 59% (five million hectares) of agricultural land in England is at risk from waterlogging, of which one-fifth is not currently drained.²⁰ Around 2.5% (200,000 hectares) of agricultural land has a 10% or greater annual probability of being flooded from rivers or the sea.²¹ Over 40,000 hectares of agricultural land were inundated during the 2007 floods, causing an estimated £50 million of damage.

At the same time, land management practices in some areas can have negative economic impacts by increasing flood risk. Field studies have shown that some farming practices can cause soil compaction, which in turn results in increased run-off, soil erosion, and sedimentation of watercourses. Particular concerns have been raised with maize cultivation (discussed further in Section 5.3.3 below).

Flooding of agricultural land is influenced by the interaction of multiple factors including flood defences, drainage and farming practices. At present flood risk management approaches tackle these issues in isolation rather than considering them together. However, there is a trend towards landowners taking a greater role in managing water levels, funded locally, to reflect the benefits gained in terms of agricultural production.

New and improved flood and coastal defences are built to protect agriculture land as part of the wider national flood risk management programme overseen by the Environment Agency. For example, 74,000 hectares of agricultural land saw an improvement in the level of flood protection in 2011/12.²² The Environment Agency also spends money maintaining existing defences, including in agricultural areas, and channel conveyance such as dredging and vegetation management. These activities, where funded by the taxpayer, represent a subsidy to farming production in areas of flood risk. It is no coincidence that much of the best agricultural land in England is at risk of flooding. In many cases it is the floodplain that is being farmed, with fertile soils created by a history of flood inundation.

²⁰ ADAS (2011) *Agricultural field under drainage installation in the United Kingdom*.

²¹ Knox, J.W. (2012) *Climate change risk assessment for the agriculture sector*.

²² Environment Agency (2013) *Written evidence to EFRA committee, 28 January 2013*.

The Environment Agency has been criticised for reducing the level of maintenance of flood defences in less populated areas, and for a perceived lack of dredging along stretches of river that have historically been maintained. The reduction in dredging and watercourse management has been driven by the need to improve value for taxpayers' money, following a critical report by the National Audit Office.²³ Less maintenance is now conducted by the Environment Agency in areas where the consequences of flooding in terms of economic losses are relatively low. Responsibilities for ongoing maintenance and drainage in lower risk areas, and the ownership of assets such as pumping stations, are being transferred from the Environment Agency to local interests. As a result, landowners are taking more responsibility in managing water levels and the risk of flooding. This is a positive trend, by creating a clearer relationship between the beneficiaries of water level management and those that pay for it.

Internal Drainage Boards (IDBs) provide a good example of the 'beneficiary pays' principle. IDBs are community-funded bodies in low lying areas that undertake works to reduce flood risk and manage water levels. Approximately 10% of land area in England is covered by an Internal Drainage Board, half of which is the highest grade of agricultural land (Grade 1).²⁴ The new Somerset Rivers Authority (SRA) extends this model. The SRA was established after the severe flooding on the Somerset Levels and Moors during the winter of 2013/14. The SRA's purpose is to deliver higher standards of flood protection than would be funded nationally, and to create better flood protection and resilience by joint planning and delivery. It is a partnership between the relevant local authorities, IDBs, the Environment Agency, and Natural England.

Defra has commissioned a review into the status of the UK's aging drainage infrastructure, to inform future action to reverse historic neglect. Although the report is complete, it has yet to be published. Flooding also forms part of a broader project estimating the economic impacts of extreme weather events.

The potential contribution of land management practices to reducing flood risk is being increasingly recognised.

Land management practices can play a role in reducing the likelihood of flooding through their effect on the water cycle. Approaches include upland water storage, peatland restoration, the management of run-off from cropped land, and riparian tree planning.

A number of on-going studies and field experiments are improving the evidence base on the contribution that land management practices can have on reducing peak flows. These include research into three experimental catchments at Pontbren in Powys, the Parrett in Somerset, and the Hodder in Lancashire. Forest Research's *Slowing the Flow* project in Pickering, North Yorkshire has been exploring the ability of better land use management to help reduce flood risk by implementing increased floodplain storage, floodplain planting and woody debris dams.²⁵ Studies by Natural Resources Wales in the Elwy catchment, where there was severe flooding in 2012, have identified reductions in flow of 28% for a 1-in-2 year annual event and 5% for a 1-in-200-year annual event.

However, it remains difficult to determine the overall significance of measures that store flood waters and manage run-off at the catchment scale, or how they will influence the magnitude and severity of more extreme floods (for example, 1-in-50 or 1-in-100 year events). Further and more widespread field studies at the catchment-scale are required.

²³ National Audit Office (2007) *Building and maintaining river and coastal flood defences in England*, www.nao.org.uk/report/building-and-maintaining-river-and-coastal-flood-defences-in-england

²⁴ Association of Drainage Authorities (2012) *An Introduction to Internal Drainage Boards (IDBs)*, <http://www.ada.org.uk/downloads/publications/IDBs-An-Introduction-web.pdf>

²⁵ See: <http://www.forestry.gov.uk/fr/slowngtheflow>

Managing the risk of flooding to agricultural land also involves trade-offs with the flooding of non-agricultural land and environmental outcomes. In some cases, allowing agricultural land to flood may be the least worst approach.




Farmers are more able, relative to occupants of residential or commercial property, to avoid flood losses by changing the crops that are grown and adjusting farming practices to be more resilient to flooding. In areas prone to flooding, appropriate choice of crop and management practices may be more cost-effective than increasing flood protection. Deciding where, when and how to address land drainage and flood prevention therefore involves a complex set of trade-offs between agricultural production, environmental impacts and the wider impacts of flooding elsewhere.

RECOMMENDATION 22: Defra, in collaboration with the Environment Agency and others such as the National Farmers Union, the Country Land and Business Association, and the Association of Drainage Authorities, should pilot integrated approaches to managing the risk of flooding to agricultural land. Approaches should incorporate catchment management, best practice farming approaches, appropriate land drainage and flood protection. This should be completed in time to inform wider dissemination of the lessons as part of the next NAP in 2018.

The NAP considers the flooding of agricultural land as part of a wider objective dominated by actions to address water availability.

NAP actions for flooding focus on capability building and research. Advisory services, such as the Farming Advice Service and the Environment Agency's Climate Ready service, provide tailored advice to improve resilience to flooding based on understanding local factors.

5.3.3. Fertility of agricultural soils

Is there a plan?		<p>The Government's policy aspiration is for all soils to be sustainably managed by 2030. The Natural Environment White Paper announced a four year research programme in 2011 to inform the action needed to meet this goal. Agri-environment schemes and CAP cross-compliance promote soil conservation.</p> <p>However, there is as yet no clear plan in place to halt the continued degradation and loss of some of the most productive lowland soils in England, particularly deep peats.</p>
Are actions taking place?		<p>The four-year research programme will draw to a close in 2016, one year behind schedule. There are a range of actions listed in the NAP to provide advice to farmers on soil conservation measures. These are mostly on-track, although some have been revised or delayed.</p>
Is progress being made in managing vulnerability?		<p>There is some evidence that soil erosion risk is decreasing, in part due to reductions in some high-risk crops (e.g. potatoes) and increases in some low-risk crops (e.g. oil seed rape). Soil conservation measures, where in place, will also be having a positive impact.</p> <p>However, a number of key indicators are in decline. Soil organic carbon levels are deteriorating nationally in arable soils. High-risk crops such as maize are increasing in some parts of the country. Lowland peat soils continue to be lost and degraded, putting at risk some of the most productive land and largest carbon stores in England.</p>

Soils are essentially a non-renewable natural asset, critical for agricultural production. They also provide a range of wider benefits, including carbon storage and slowing the water cycle.

Soils are formed by the weathering of rocks and minerals and the accumulation of organic materials, which often takes hundreds to thousands of years. Rates of formation vary, but are generally less than 1 cm per century for mineral soils in the UK.²⁶ The loss of soil by erosion is also a natural process, but it can be very rapid and accelerated by how land is used and managed. Rates of soil loss can be much greater than its formation, hence soils should be considered as a non-renewable resource.

The depth, volume, amount of organic matter, and quality of soil, are all of critical importance for the productive capacity of agricultural land. Erosion and loss of soil organic matter reduces yields and imposes additional production costs such as increasing the need for fertiliser or irrigation. It has been estimated that around 2.2 million tonnes of top soil is eroded annually in England and Wales, affecting agricultural production and nutrient availability.²⁷

Soil erosion also has adverse impacts on the water environment. Sedimentation accounts for around 5% of water bodies failing to meet good ecological status under the Water Framework Directive (see Chapter 6: Natural Environment).

An estimated 10 billion tonnes of carbon are stored in UK soils.²⁸ This dwarfs the 0.2 billion tonnes in UK vegetation. Due to losses of soil organic carbon, around 12 million tonnes of carbon dioxide is emitted to the atmosphere each year from UK soils.²⁹

The benefits of well-managed soils go beyond yields and form part of the solution to adapting to other climate change risks. UK soils store an estimated 130 trillion litres of water, much more than are contained in all surface water bodies combined, including lakes and rivers.³⁰ As discussed in Section 5.3.2 above, soils in good condition help to slow the water cycle through infiltration of rainwater, and so play an important role in managing flood risk. Degraded and compacted soils can have the opposite effect, exacerbating flood risk by increasing the speed of rainwater run-off and silting up rivers.

Agricultural soils have experienced significant changes in the way they are managed over recent decades, which are likely to be increasing their vulnerability to climate change impacts.

In the last 50 years, UK agricultural soils have been subject to increased mechanisation, the use of agrochemicals and synthetic fertilisers, and the introduction of new crop varieties. Increased frequency and depth of tillage, reductions in land under forage crops, and continuous use for grain cereals, have all led to concerns about declining soil organic matter and increasing soil erosion.

Warmer, wetter winters and drier summers in the future could affect rates of soil weathering and increase soil erosion from both water and wind. Warming of organic (peaty) soils is likely to exacerbate loss of soil carbon through accelerated decomposition of organic matter. Sea-level rise will also increase brackish water encroachment on lowland coastal areas, leading to localised risk of soil salinisation.

²⁶ UK National Ecosystem Assessment (2011) *Synthesis of key findings*, <http://uknea.unep-wcmc.org/Resources/tabid/82/Default.aspx>

²⁷ Environment Agency (2004) *The state of soils in England and Wales*, http://www.adlib.ac.uk/resources/000/030/045/stateofsoils_775492.pdf

²⁸ Defra (2009) *Safeguarding our soils: A strategy for England*, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69261/pb13297-soil-strategy-090910.pdf

²⁹ See: http://naei.defra.gov.uk/reports/reports?report_id=810

³⁰ See: ASC (2013) for a more detailed summary, and references.

The available evidence suggests that soil organic carbon is declining nationally in arable soils. This will have implications for future productivity of agriculture.

Estimates vary but soil organic carbon has been flat or declining over the period from the late 1970s to the early 2000s. There have been particularly marked declines in the most carbon-rich soils, such as peat. The National Soil Inventory reported a decrease in soil organic carbon of about 0.7 grams per kilogram per year in all soils over the period from 1978 to 2003. Although losses on arable soils were lower at around 0.4 grams per kilogram each year, supporting analysis found more significant losses of over 5 grams per kilogram per year on the most carbon-rich arable soils.³¹

The Countryside Survey for England found a decrease in soil organic carbon of about 3 grams per kilogram per year across soils currently under arable and horticultural production. Unlike the National Soil Inventory, however, the Countryside Survey found no significant change in soil organic carbon across all soils for the period from 1978 to 2007.³²

Vulnerability to soil erosion may be reducing at a national level due to changes to cropping patterns, although it is likely to be increasing in some areas.

Actual soil erosion is difficult to monitor over time at the national scale. However, modelling of the factors associated with soil erosion suggests risk has decreased gradually across all grades of agricultural land since the 1960s. This is primarily due to changes in cropping types over time (Figure 5.2). In particular, there has been an increase in the proportion of agricultural land covered by low risk crops such as oil seed rape where on average only one field in 100 is at risk of erosion. The area of agricultural land covered by oil seed rape doubled between 1988 and 2010. At the same time, the area covered by potatoes and sugar beet, which are both high risk crops, has declined by around one-third.³³

There has, however, been a five-fold increase in the area of land under the high-risk crop of maize, from 27,000 hectares in 1988 to 126,000 hectares in 2010. The area has since increased even more rapidly, to 196,000 hectares in 2014. Of this, the majority (93%) was grown in England. The main use of maize is as a forage crop to feed livestock. However, nearly 15% of maize production (29,000 hectares in 2014) is being grown to provide feedstock to anaerobic digestion plants for bio-energy.³⁴

There are some notable regional variations in the national picture. This suggests that erosion risk may be increasing in some parts of the country. Nearly one-third (31%) of national maize production in 2010 was located in the south west of England. Where maize is replacing grassland, the risks of increased erosion rates are even higher and this is especially the case if the crop is being planted on slopes. A survey of over 3,000 sites in south-west England found that the soil structure of three-quarters of fields under maize were damaged to the extent that rainfall is unable penetrate the upper soil layers, resulting in silt-laden run-off during periods of heavy rainfall.³⁵

³¹ Cranfield University (2013) *National Soil Inventory Database* (Topsoil data for 1983 and 1995).

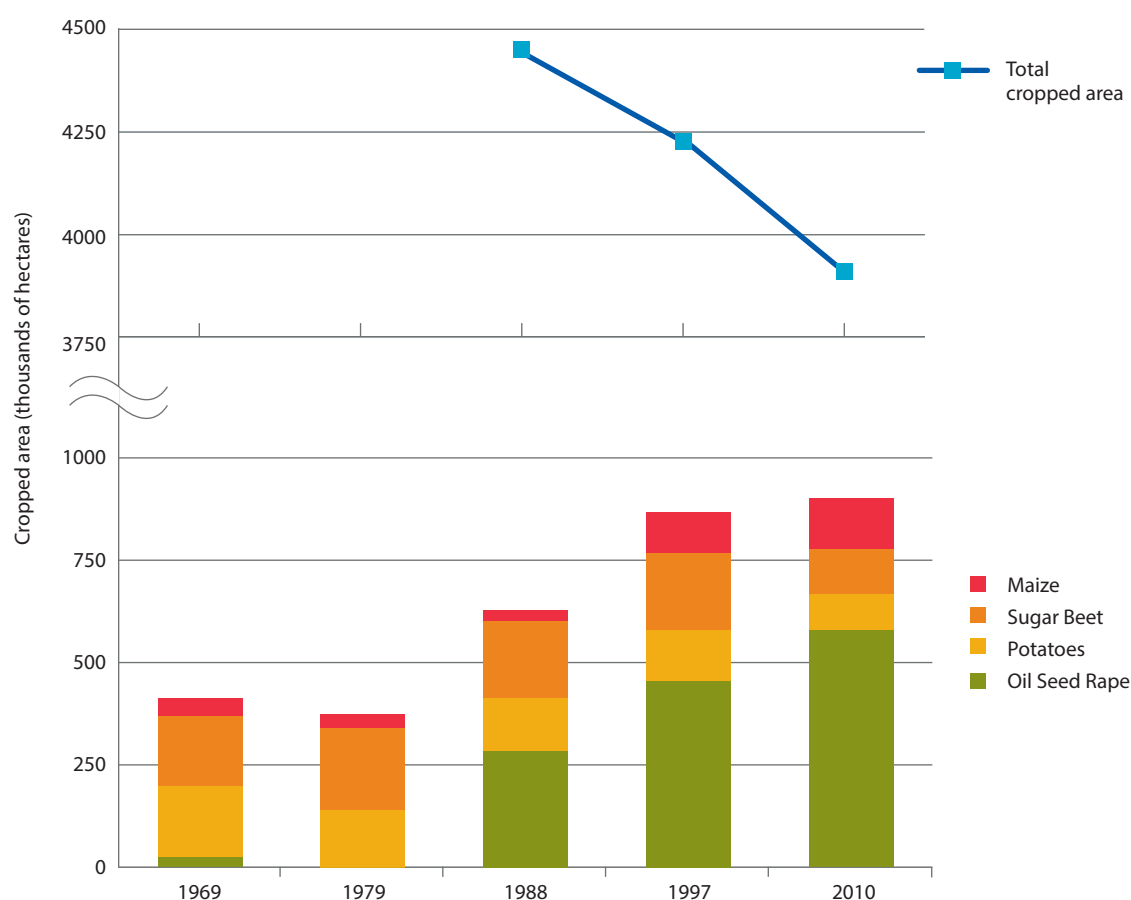
³² Carey, P.D. et al. (2008) Countryside Survey: UK headline messages from 2007. *NERC/Centre for Ecology and Hydrology*, 30pp.

³³ One field in ten of potatoes and one field in seven of sugar beet are at risk of erosion. See Cranfield University (2015) for the ASC. *Research to develop the evidence base on soil erosion and water use in agriculture*.

³⁴ *Ibid.*

³⁵ Palmer, R.C. and Smith, R.P. (2013) Soil structural degradation in SW England and its impact on surface-water run-off generation. *Soil Use and Management*, 29 Issue 4

Figure 5.2: Agricultural land by crop type



Source: June Agricultural Census.

Notes: This graph shows the changes over time in the area of agricultural land covered by selected high erosion risk crops (sugar beet, potatoes and maize) and low erosion risk crops (oil seed rape). This is based on data from the Edinburgh University Data Library (EDiNA) analysed in Cranfield University (2015) for the ASC. While based on the same survey, these figures differ slightly to the aggregate June Agricultural Census data published by Defra. This is partly because the EDiNA converts the data collected for each parish into data for each kilometre grid square of England to allow trends in crop types to be mapped spatially. No data were available for the area of oil seed rape under cultivation in 1979. The total cropped area line is based on the aggregate June Agricultural Census data published by Defra.

The continued degradation and loss of lowland peat soils means that some of the most productive agricultural land in England is expected to become economically unviable within decades.

Lowland peat soils are of strategic agricultural importance, making up a significant proportion of Grade 1 and Grade 2 land in England. Peat soils have high organic content (over 50%) and as such tend to be very fertile. Such land provides a comparative advantage for intensive high-value cropping, including vegetables, salads and horticulture.³⁶

³⁶ Graves, A. and Morris, J. (2013) for the ASC. *Restoration of fenland peatland under climate change*, http://www.theccc.org.uk/wp-content/uploads/2013/07/Report-for-ASC-project_FINAL-9-July.pdf

There are around 325,000 hectares of lowland peat soils in England, of which three-quarters (240,000 hectares) are under cultivation or intensive grassland. 30,000 hectares of lowland peat remain as semi-natural habitat. Of that, around 21,000 hectares are designated as SSSIs (see Chapter 6: Natural Environment).³⁷

The largest single area of lowland peat soils is in the East Anglian Fens, which cover around 130,000 hectares. The Fens account for around 10% of the national area of agricultural land given over to potatoes, sugar beet and vegetable production.³⁸ Only 34,000 hectares remain as deep peat (i.e. over 0.4 metres in depth). The remaining peat soils in the Fens are now classed as 'wasted' following years of degradation, shrinkage and loss. Almost all of the area is dependent on continued pump drainage, as much of the landscape is now below sea-level following centuries of farming-induced subsidence.

The loss of peat soils in the Fens has been occurring for hundreds of years. Today, only around 16% of the peat stock recorded in 1850 remains and much of this will be irreversibly degraded in the next few decades if current land use practices continue. Arable production typically requires deep ploughing and power harrowing, alongside intensive drainage, in order to achieve fine seedbeds. Arable production has resulted in peat losses at an observed rate of 10mm to 30mm a year.³⁹ Climate change is expected to accelerate these losses, with every 1°C rise in temperatures increasing the rate of loss by 30%.⁴⁰

Deep peat soils are currently very profitable. The annual net margin of arable production on deep peat Fen soils is on average £480 per hectare.⁴¹ High-value cropping of potatoes, vegetables and salads can achieve even higher annual net margins of £1,800 to £2,500 per hectare. However, wasted peats are much less fertile than deep peats, are difficult to work and subject to poor drainage. As such, the average net margin is around £27 per hectare. High-value cropping is not viable on these soils, with only cereals, oil seeds and possibly sugar beet available. If the remaining deep peats are lost, it is clear that the profitability of agriculture on the Fens will diminish.⁴²

The continuation of intensive cropping on deep peats also has a high price in terms of CO₂ emissions. If the cost of these emissions is included in the net margins, then the current value of intensive arable production on deep peat falls from £480 to £45 per hectare. By the 2050s, with both climate change and the increase in the price of carbon, the net margin is projected to between -£79 per hectare (low emissions scenario, 10th percentile) and -£458 per hectare (high emissions scenario, 90th percentile).

³⁷ See: <https://www.gov.uk/government/publications/england-biodiversity-indicators>

³⁸ Note that the wider East Anglian Fenland area of over 500,000 hectares, including non-peat soils, accounts for around 37% of England's area of vegetables grown in the open, 24% of potatoes and 17% of bulbs and flowers.

³⁹ See ASC (2013) for references.

⁴⁰ Graves, A. and Morris, J. (2013) for the ASC.

⁴¹ Note that this does not include or account for income from the single farm payment under EU CAP (Pillar 1), which is on average around £200-250 per hectare per year.

⁴² Graves, A. and Morris, J. (2013) for the ASC.

In areas where soils are being steadily lost and soil carbon is declining, the only feasible adaptation response is to change current farming systems.

In the Fens and other areas of lowland deep peats, it would be possible for some form of agriculture to continue in ways that conserve the peat resource. Reverting from intensive arable systems to extensive wet grasslands would result in net margins of £38 per hectare now and into the future when the carbon price is included, as it would conserve the peat and not increase CO₂ emissions.⁴³ Other potentially viable alternatives to intensive arable farming that would potentially conserve peat are the production of perennial biomass crops and agro-forestry.

In other areas, the widespread uptake of soil conservation and protection measures may be sufficient to manage the vulnerability of agricultural soils to a changing climate.

There are a range of measures available to improve soil conservation and protect vulnerable soils from erosion that will still allow current agricultural production to continue.

- **Reducing soil erosion and protecting watercourses:** measures include the creation of low-input grass 'buffer strips' along the edges of fields, taking field corners out of production, and fencing to stop livestock from entering watercourses.
- **Minimising the length of time that soil is left bare:** measures include planting winter cover crops or under sowing spring cereals. The timing of field operations, from seedbed preparation through to harvesting, can be managed to reduce risks.
- **Organic returns:** applying manures, straw residues and other organic waste products can potentially maintain or increase soil organic carbon levels and reduce erosion risk. An estimated 30 million tonnes of organic wastes are produced each year in the UK but not returned to the land.⁴⁴ There can, however, be trade-offs with organic returns that require careful management, such as pollution risk and contamination of soils. In some cases the cost-effectiveness of these measures is likely to be low.
- **Tillage operations:** shallow ploughing, or 'reduced tillage', keeps organic matter nearer to the surface and reduces the risk of soil compaction. Shallow ploughing made up nearly 40% of all tillage operations for winter wheat (the most widespread arable crop) in 2010 compared to less than 10% in the mid-1990s.⁴⁵ However, this is thought to be as a response to higher fuel prices over that time rather than due to a need to reduce erosion risk. As such deep ploughing may increase again in the future.

The need to improve the sustainable management of agricultural soils is recognised by Government. The necessary mechanisms to deliver its policy goals are not yet in place.

Announced in 2009 and reiterated in the 2011 Natural Environment White Paper, the Government has set an ambition that all soils will be managed sustainably by 2030. The first step towards that goal has been a four year research programme to develop the evidence base. The programme will be completed in 2016, one year behind schedule. The intention is for this research to inform policy options that may be necessary for the 2030 goal to be achieved.

There are a number of mechanisms in place to provide farmers with an incentive to improve soil conservation, referred to in the NAP, including:

⁴³ *Ibid.*

⁴⁴ House of Lords Science and Technology Select Committee (2014) *Waste or resource? Stimulating a bioeconomy*, <http://www.publications.parliament.uk/pa/ld201314/ldselect/ldscitech/141/141.pdf>

⁴⁵ Cranfield University (2015) for the ASC.

- **Soil Protection Review (SPR):** part of cross-compliance under Pillar I of the CAP. This refers to the requirement for farmers to keep their land in Good Agricultural and Environmental Condition (GAEC) in order to qualify for the full single farm payment. The SPR requires farmers to identify the risks of soil erosion, compaction and organic matter loss on their land and put in place a minimum number of measures to prevent that risk. A new set of outcome-based rules for soil protection will be introduced under the cross-compliance scheme from 2015. The new rules will require claimants to take action to protect soil by providing minimum soil cover, taking measures to prevent erosion, and maintaining soil organic matter levels.
- **Environmental Stewardship scheme:** a voluntary agri-environment scheme under Pillar II of the CAP that has been in operation since 2007. The Entry Level Scheme (ELS) contains a set of prescriptions providing basic environmental protection and enhancement. These include soil conservation and protection measures such as buffer strips and cover crops. Entrants to the scheme are paid for any income foregone by taking up these options. The ELS has been a popular option with farmers, covering 72% of all available farmland in England in 2013 (6.5 million hectares). Of this, around 1.2 million hectares were under options identified as being a priority for soil and water conservation.⁴⁶
- **Catchment Sensitive Farming:** an advisory programme led by the Environment Agency which provides advice and capital grants to farmers in order to reduce diffuse water pollution, including that caused by soil erosion. The programme is focused on 80 priority catchments in England covering a total of nearly two million hectares. Since its start in 2006, 218,000 specific recommendations have been made to farmers, of which 62% had been implemented by 2013. Capital grants are available through the scheme for measures such as fencing watercourses, sediment ponds, swales, piped culverts and sheep dips.




In addition, the EA Climate Ready service and the Farm Resilience Plans pilot include advice on soil management.

Despite these actions, the on-going declines in soil carbon and continued loss of lowland peat suggests that current policy interventions will not deliver the 2030 aspiration for all soils to be sustainably managed. Furthermore, the NAP does not place any emphasis on the need to improve the resilience of agricultural soils in the face of climate change. This is especially the case with lowland peat soils where action to arrest carbon losses is now critical.

RECOMMENDATION 23: Defra should take action to deliver its policy aspiration for all soils to be sustainably managed by 2030, publishing an action plan within a year of this report to describe how the goal will be achieved. The action plan should include proposals for establishing a scheme to monitor the uptake of soil conservation measures, with enforcement where soils are not being appropriately managed. The action plan should include specific proposals to reverse the on-going loss of lowland peat soils, and should be developed in partnership with the farming sector.

⁴⁶ See: <https://www.gov.uk/government/publications/england-biodiversity-indicators>

5.3.4. Climatic suitability of tree species

Is there a plan?		The Public Forest Estate is covered by the Climate Change Action Plan for Public Forests. Government's Forestry and Woodland Policy Statement 2013 includes a target to increase the area of woodland under active management to 66% by 2018 (from 48% in 2008). Climate change adaptation is embedded in the UK Forestry Standard and in measures covered by the Rural Development Programme for England.
Are actions taking place?		<p>The majority of relevant NAP actions are either complete or on-track. A key action to meet the target of 66% of forestry under active management by 2018 is likely to be met, and is currently standing at 58%.</p> <p>The England Woodland and Timber Partnership had responsibility under the NAP for developing a Climate Change Action Plan for the sector, but has since been disbanded. A sector accord has been developed instead of the original action and is due for publication.</p>
Is progress being made in managing vulnerability?		<p>The diversity of conifer species planted in the public estate is increasing, offering a degree of insurance against changing climatic conditions. Planting locations of oak, beech, pine and spruce have been changed over time to become more suitable for the future climate.</p> <p>There is less evidence available on private estates but there has been progress in expanding the area under active management, which should lead to a greater focus on adaptation.</p>

Given the long rotation times involved, the forestry sector needs to ensure as far as possible that trees being planted now will thrive in the future climate.

Previous analysis by the ASC showed that between 5% and 40% of oak, pine, spruce and beech trees planted in the last 40 years are situated in areas that may not be suitable for timber production in the 2050s.⁴⁷ These metrics have been incorporated into ongoing monitoring by the Forestry Commission, which is being extended to cover 57 species.

Given the uncertainty surrounding future climatic conditions, increasing the diversity of the tree stock provides insurance against a range of outcomes. Greater diversity of species also makes woodland more resilient to pests and disease outbreaks. Diversity of planting is increasing in the Public Forest Estate with the number of different conifer species planted increasing from 11 in 2005/06 to 25 in 2013/14. The dominance of a few conifer species has reduced. Around 41% of conifers planted in 2013/14 were Sitka Spruce, down from 58% in 2005/06. However, the combined share of the top five species planted in any one year has declined only four percentage points over that period. Together the top five still make up 87% of trees planted.⁴⁸

Greater diversity of tree planting is only taking place in woodland that is actively managed. There has been good progress in bringing more woodland under active management over the last few years.

A greater proportion of forests and woodland under private ownership needs to be actively managed to increase their resilience to climate change. In 2011 the Government announced a target to have 66% of all UK woodland under active management by 2018. On the current trajectory it is likely that the target will be met. In March 2015 the proportion of woodland actively managed stood at 58%, up six percentage points since the target was set in 2011 and only marginally behind a linear path out to the target in 2018.⁴⁹

⁴⁷ ASC (2013).

⁴⁸ Figures provided by the Forestry Commission. The top five species planted in 2013/14 were Norway Spruce, Sitka Spruce, Scots Pine, Douglas Fir and Western Red Cedar.

⁴⁹ Forestry Commission (2015) *Corporate plan performance indicators*, [http://www.forestry.gov.uk/pdf/FC-England-Indicators-Report-20152.pdf/\\$FILE/FC-England-Indicators-Report-20152.pdf](http://www.forestry.gov.uk/pdf/FC-England-Indicators-Report-20152.pdf/$FILE/FC-England-Indicators-Report-20152.pdf)

The NAP's approach to ensuring climatic suitability of tree species is reasonably comprehensive. Progress against these actions has been good.




There has been progress on most of the NAP actions in this area. Adaptation is embedded in key government policies and guidance documents, including:

- the Government's Forestry and Woodlands Policy Statement in 2013, in response to the July 2012 report by the Independent Panel on Forestry;
- wildfire guidance, included in the UK Forestry Standard in April 2014; and
- a campaign to promote the UK Forestry Standard Climate Change guidelines, consisting of seminars, social media campaigns, and a quick start guide.

Incentives for the sector to follow these guidelines are in place. Recipients of Rural Development Programme for England (2014 - 2020) grants will have to meet the UK Forestry Standard Climate Change guidelines. Evaluation of Countryside Stewardship grant applications will be tailored to support the key biodiversity and water management objectives of the Natural Environment White Paper. *Grown in Britain* licences require adherence to the UK Forestry Standard and the use of appropriate felling licences. There have been 12 applications for *Grown in Britain* licences, including 12,000 hectares of publicly owned Crown Estate forests.

One key action in the NAP has been revised. The England Woodland Timber Partnership (EWTP) was due to publish an action plan for the industry. The EWTP has since been disbanded. An industry accord has been developed in its place and its publication is due.

5.3.5. Prevalence of new and existing pests and diseases

Is there a plan?		Climate change is embedded in key plant health policy documents including the Tree Health and Plant Biosecurity Action Plan, and the Forestry and Woodlands Policy Statement. Prevention and control of animal disease is covered by EU policy which incorporates climate change.
Are actions taking place?		The majority of NAP actions relating to pests and diseases are either complete or on-track. Publication of the Defra review of Invasive Non-native Species Framework Strategy for Great Britain has been delayed by a few months but is due for publication in 2015.
Is progress being made in managing vulnerability?		The effects of climate change on the changing incidence of specific pests and diseases in England is highly uncertain. Further research is needed on this issue.

The precise impacts of climate change on pest and disease risks in the UK are highly uncertain. The appropriate policy response is therefore to improve surveillance, general pest and disease risk management, and embed climate change considerations into new analysis and strategies.

The main drivers of risk from pests and diseases to both agriculture and forestry are socioeconomic, particularly global trade. Climate change will alter the conditions under which different invasive non-native species may thrive but the specific effects are highly uncertain.⁵⁰ The Government has set out its plans for tackling pest and disease threats to plant and tree health in the Tree Health and Plant Biosecurity Action Plan, and the Forestry and Woodlands Policy Statement. Livestock diseases are covered by the EU Animal Health Strategy. The Animal and Plant Health Agency and the Forestry Commission are responsible for monitoring and responding to pests and disease threats to agriculture and forestry. Both have embedded climate change into their planning and surveillance arrangements.

There have been major changes to the management of plant health risks in recent years following the publication of the final report of the Tree Health and Plant Biosecurity Expert Taskforce in May 2013. Notably:

- The first UK Chief Plant Health Officer took office in April 2014.
- A UK Plant Health Risk Register has been produced by the Food and Environment Research Agency Fera. Responsibility for the Register has been transferred to Defra following changes to Fera earlier this year.
- A Plant Biosecurity Strategy and a Tree Health Management Plan were published in April 2014, addressing the recommendations of the Tree Health and Biosecurity Expert Taskforce.

The majority of the NAP actions in this area are general rather than specific to the risks from climate change. There is also a bias towards risks to plant health as opposed to animal health.




Many of the NAP actions aimed at improving the resilience of agriculture and forestry to pests and diseases are of general importance, rather than aiming to counter climate change in particular. This is broadly appropriate given the uncertainty over the precise effects that climate change will have on these risks. Most of the actions reflect the current drive to improve the management of plant health risk. As a result, animal health receives much less attention in the NAP.

There has been progress in areas specifically aimed at addressing the risks from climate change, particularly through research to better understand the nature of the risks. Actions include the Tree Health and Plant Biosecurity Initiative research programme, research to fill the evidence gap on the effects of climate change on pests and diseases that affect livestock, and for environmental change factors to be considered for each risk in the new UK Plant Health Risk Register. In addition, Defra will soon publish its review of the Invasive Non-native Species Framework Strategy for Great Britain.

RECOMMENDATION 24: Defra should use the information contained within the UK Plant Health Risk Register to publish aggregate metrics that enable the overall risk from pests and diseases to be monitored over time. This should be completed in time to inform the ASC's next progress report in 2017.

⁵⁰ Knox, J.W. (2012) *Climate change risk assessment for the agriculture sector*.

5.3.6. Innovation and knowledge transfer

Is there a plan?		Climate change adaptation is embedded in both the Agri-Tech Strategy and the Science and Innovation Strategy for British forestry. Knowledge transfer is supported by the Farming Advice Survey, the Environment Agency, Climate Ready service, Catchment Sensitive Farming, and Natural England Farm Resilience Plans.
Are actions taking place?		There has been progress against most of the NAP actions that promote or commission research, and with knowledge transfer and capacity-building schemes. However, research on soils and the water efficiency traits of different crops has been delayed.
Is progress being made in managing vulnerability?		Compared to other European countries and in the USA, the productivity of the agricultural sector has grown more slowly since the 1970s. R&D spending in the UK has declined by around a fifth in real terms since 1987. It is too early to tell whether recent action, such as the Agri-Tech Strategy, has had any effect on these long-term trends..

The growth in productivity of the agriculture and forestry sectors has fallen behind that of other advanced economies over the course of the last few decades. Research spending has also declined.

The agriculture and forestry sectors have the best chance of meeting future challenges, and taking advantage of new opportunities, if they have evidence-based practices and a range of technologies available. In the context of climate change adaptation, this means knowing how best to manage the land, how to control pests and diseases, and how to select the appropriate crops, livestock and trees for the future climate.

However, over a period of decades, investment in and uptake of technology by UK agriculture has declined relative to other nations. Following real terms growth of 6% per year from 1953 to 1982, research and development (R&D) spending fell by around a fifth in real terms between 1987 and 2009. This was largely driven by reductions in spending by the public sector.⁵¹ Over the period between 1973 and 2002, total factor productivity rose more slowly in the UK relative to other European countries and the USA.⁵² Total factor productivity is a measure of how efficiently inputs are combined to create economic outputs, much of which depends on the development and uptake of technology and good practice.

Efforts are underway to reverse this trend, covering both new research and its dissemination. However, it is too early to tell the impact these efforts have had.

The Government published an Agri-Tech Strategy in July 2013, to improve the productivity, sustainability and competitiveness of the agricultural industry. It aims to plug a gap in applied research, facilitate collaboration between industry and public and private research institutions, and disseminate findings to farmers. There have been two rounds of the Agri-Tech Catalyst, with agreed funding of more than 30 research and industry collaborations on innovative technologies. A third round is currently underway. The Government has also committed £90 million of investment to establish a small number of Centres for Agricultural Innovation. In December 2014, a preferred bidder was selected for the first of these centres, which will be a centre for excellence in agri-informatics and sustainability metrics. Monitoring the effectiveness of the activities under the Agri-Tech Strategy will be important for informing future policies to encourage innovation and knowledge transfer.

⁵¹ OECD (2013) *Research and development statistics*, <http://www.oecd.org/innovation/inno/researchanddevelopmentstatisticsrds.htm>

⁵² Fugile, K. O. (2012) *Productivity growth and technology capital in the global agricultural economy*.

RECOMMENDATION 25: Defra should publish an initial evaluation of the impact of the Agri-Tech Strategy in time to inform the next NAP in 2018.

Knowledge and best practice is being disseminated by initiatives such as the Environment Agency Climate Ready service, the Farming Advice Service, Catchment Sensitive Farming, and Natural England Farm Resilience Plans. Funding is also available for capital projects that boost productivity under the Rural Development Programme for England (2014 – 2020).

5.4 Conclusions on NAP objectives and actions

The table below summarises progress against the objectives listed within the NAP for the agriculture and forestry theme. In general, the objectives describe a number of processes and list actions by which the resilience of the sectors should be improved. Full details of progress against each action in the NAP can be found in an annex to this report available on the CCC's website.

Of the 50 actions in the agriculture and forestry chapter of the NAP:

- 16 (32%) are complete;
- 24 (48%) are on-track;
- 7 (14%) have been revised or delayed; and
- 1 (2%) has been dropped.

The majority (72%) of actions are time-bound with the remainder classed as 'on-going'. Updates were not provided to the ASC for 2 (4%) of the actions.

Table 5.1: NAP objectives and a summary of progress for the agriculture and forestry theme

NAP objective	Commentary on progress
Objective 15. To increase the resilience of agriculture by effectively managing the impact of volatility in the occurrence and severity of rainfall events on water availability, flooding, soil erosion and pollution due to run-off.	<p>There are 17 actions for this objective. These cover issues related to the first three adaptation priorities of this report, on water use, flooding and soil condition. The actions include a mix of research to address major evidence gaps, increasing awareness, and five actions focussed on taking actions today to directly manage long-term risks.</p> <p>The majority (76%) of the actions are complete or on-track. Three of the other actions have been delayed. This includes a review by Defra of the support available to farmers to manage their water availability ahead of reforms to the abstraction system, which has been pushed back to 2018. The remaining action, for the Campaign for the Farmed Environment (CFE), NFU and others to build national awareness of the priorities for climate change adaptation, has been dropped. The update on the NAP action highlights this was due to reduced budgets, but notes that it is expected that adaptation and resilience are implicit in the work of the CFE.</p> <p>While there is some evidence of progress being made, such as in the trends in water demand by agriculture, other important indicators are heading in the wrong direction, particularly for soils.</p>

Table 5.1: NAP objectives and a summary of progress for the agriculture and forestry theme

NAP objective	Commentary on progress
<p>Objective 16. To increase the resilience of the forestry sector by increasing the level of management in England's woodlands and the uptake of adaptation good practice in woodland creation and restocking.</p>	<p>There are 12 actions for this objective. These include the implementation of the Forestry Commission's Climate Change Action Plan and the Government's Forestry and Woodlands Policy Statement, which includes the aim to increase the area of woodland under active management to 66% by 2018. There is also an action that is on-going to implement the Woodland Carbon Code, a voluntary code that provides independent certification of carbon sequestration for woodland creation projects in the UK.</p> <p>Two of the actions are complete and eight are on-track. The remaining two have been revised or delayed. In particular, the England Woodland Timber Partnership has been dissolved and is no longer taking forward plans to raise awareness, transfer knowledge and promote best practice among private forest owners. In its place a sector accord has been drafted and is due to be finalised shortly.</p> <p>Progress is being made in managing the risks from climate change to the forestry sector. The proportion of private forest estates under active management is increasing as well as the diversity of tree species planted on the public forest estate.</p>
<p>Objective 17. To increase resilience to pests and disease to help protect biodiversity, maintain agricultural and forestry productivity and protect the UK's ability to export products.</p>	<p>There are 12 actions for this objective. The majority of these actions focus on addressing major evidence gaps on the risks to plant and tree health from pests and diseases. Two of the actions relate to integrating climate risks into future pest risk assessments and plant health protection programmes led by the Food and Environment Research Agency.</p> <p>One of these actions is complete and nine are on-track. The action to review the Non-native Species Framework Strategy for Great Britain by the end of 2014 has been delayed and will now be completed in 2015. The remaining action, for Defra to lobby the European Union to increase its capacity to anticipate and monitor new and emerging exotic livestock diseases across Europe, has been revised following the publication of an EU white paper on improving monitoring and the evidence base.</p> <p>The precise impact of climate change on pest and disease risks to the UK are highly uncertain. The appropriate policy response is therefore to improve general pest and disease risk management and embed climate change considerations into new analysis and strategies. This appears to be happening, although it is unclear if this is the case for risks to animal health given its limited coverage in the NAP.</p>

Table 5.1: NAP objectives and a summary of progress for the agriculture and forestry theme

NAP objective	Commentary on progress
<p>Objective 18. To embed climate change adaptation into agriculture, horticulture and forestry research programmes, in order to improve knowledge of likely climate impacts and contribute to the development and uptake of climate resilient crops, tree and livestock species as well as relevant technologies.</p>	<p>There are nine actions for this objective. These mainly focus on undertaking research to address major evidence gaps. This includes research by Defra on the effects of soil degradation on soil function, the impact of extreme weather on agriculture, the water efficiency traits in crops at different carbon dioxide levels, and the resilience of UK agriculture to climate change through the new Sustainable Intensification Research Programme. There is also an action for BIS to drive sustained growth through the Agri-Tech strategy.</p> <p>Four of these actions are complete and three are on-track. The ASC did not receive an update on the progress of the remaining two actions on the research programmes owned by the Biotechnology and Biological Sciences Research Council, and the Natural Environment Research Council.</p> <p>It is too early to say if the development and dissemination of knowledge and information in the NAP is helping to reduce vulnerability to climate change and reverse the long-term decline in productivity. The ASC will return to this issue in future reports.</p>



Chapter 6: Natural environment

- 6.1 The importance of the natural environment
- 6.2 Risks to the natural environment from climate change
- 6.3 Progress being made
- 6.4 Conclusions on NAP objectives and actions



Key messages

Climate change represents a substantial risk to England's wildlife and the essential goods and services provided by the natural environment, such as clean air, clean water and carbon storage. This is particularly the case where the natural environment is already stressed by other, non-climate pressures including pollution, habitat fragmentation, adverse management and over-exploitation.

Plans are in place that aim to halt and reverse decades of degradation and fragmentation of the natural environment. There is evidence of actions being taken to restore species, habitats and ecosystems, and hence reduce vulnerability to climate change. Despite these efforts key indicators of environmental quality continue to move in the wrong direction. Climate change is already adding to pressures on the natural environment, and in the absence of further effort to build resilience is likely to accelerate rates of decline.

Overview of progress

Adaptation priority	Is there a plan?	Are actions taking place?	Is progress being made in managing vulnerability?
1. Ecological condition of natural assets:			
(a) Terrestrial habitats – woodlands, heaths, grasslands	Green	Green	Amber
(b) Wetland habitats – peat bogs, fens, marsh	Green	Amber	Red
(c) Coastal habitats – saltmarsh, mudflats, dunes	Green	Green	Green
(d) Water bodies – rivers, lakes, estuaries	Green	Green	Amber
(e) Farmed countryside	Amber	Green	Red
(f) Marine environment	Green	Amber	Amber
2. Extent of priority habitats	Green	Green	Amber
3. Coherence of ecological networks	Amber	Green	Amber

Key messages

Note: The criteria for Red, Amber, Green or Grey status for each of the three questions are as follows:

Is there a Plan? Green - where needed, plans or policies are in place that fully address the adaptation priority in the context of climate change. Amber - plans or policies are in place that partially address the adaptation priority. Red - no specific policies or plans are in place

Are actions taking place? Green - all relevant NAP actions are complete or on-track, other relevant actions or commitments are being implemented. Amber - not all relevant NAP actions complete or on-track, partial delivery of other actions or commitments. Red - NAP actions mostly delayed or dropped, other relevant actions behind schedule.

Is progress being made in managing vulnerability? Green - trends in vulnerability are reducing or not increasing; there is high uptake of low-regret adaptation measures; long-term decisions are accounting for the future climate. Amber - some trends in vulnerability are increasing; scope to increase low-regret adaptation, decisions partially or inconsistently account for the future climate. Red - most trends in vulnerability increasing; minimal or zero uptake of low-regret adaptation; long-term decisions not taking the future climate into account. Grey - insufficient evidence to make a judgement.

See Chapter 1 for a full description of the approach.

Summary of progress

Over the last decade important steps have been taken to build the resilience of England's natural environment so that it will be better able to accommodate changes in climate.

- **The Government has set ambitious goals to enhance and restore biodiversity.** The Biodiversity 2020 strategy aims to reverse the long-term decline in England's natural capital. Goals have been set to improve the condition of protected sites, increase the amount of priority habitat, and restore degraded ecosystems, such as peatlands and woodlands. Achieving these goals would do much to increase the resilience of the natural environment to climate change.
- **The economic case for accounting for natural capital and investing in its restoration is beginning to be recognised.** The Natural Capital Committee (NCC) has demonstrated that it is both desirable and feasible to introduce the value of natural capital into accounting processes. The NCC has made a strong business case for investment in the restoration of peatlands, coastal habitats and urban greenspace for the benefits provided to society.
- **The great majority (95%) of protected sites are now recorded as being in either a favourable or recovering condition.** Significant effort has been made over the last decade to improve the ecological condition of protected wildlife sites. This has mainly been delivered through agri-environment schemes funded under the EU Common Agriculture Policy. Protected sites that are not in a favourable condition but covered by a scheme are classed as 'recovering', on the basis that a management agreement is in place. As a result, the proportion of the protected area network categorised as recovering increased from 13% in 2003 to 59% in 2014. However, these sites will only reach favourable condition if the agreed interventions are delivered and sustained.
- **New habitat is being created that is starting to counter decades of fragmentation and loss.** Over 60,000 hectares of new habitat has been created since 2011, including new woodlands, heaths and urban greenspace. New coastal habitat is also being created, which will at least partly compensate for the losses being caused by sea level rise.
- **Widespread take-up of agri-environment schemes has brought about some improvements in the way farmed land is managed for biodiversity.** As well as improving the condition of protected sites and creating new habitat, agri-environment schemes have paid for measures such as hedgerow planting, small woodland management, and buffer strips around cultivated fields. By 2014, over 70% of agricultural land in England was covered by the Environmental Stewardship scheme.

Key messages

- **Legislation is in place to protect and enhance the water environment.** A strategic and long-term approach to implementing the EU Water Framework Directive has been established through River Basin Management Plans. Over £1 billion has been allocated in water company business plans to environmental improvements between 2015 and 2020. Water companies and the Environment Agency are taking action to reduce the impacts of over-abstraction on sensitive freshwater habitats. Water companies have also been prominent in developing catchment management approaches.
- **Some progress is being made in addressing the degradation of the marine environment.** The area of England's inshore waters that is protected has increased by over 250% since 2011, albeit from a low base. Reforms to the EU Common Fisheries Policy are reducing unsustainable practices. Regulations such as the Bathing Waters Directive are leading to decreases in pollution. An overarching EU policy for marine protection, the Marine Strategy Framework Directive, has recently come into effect and a statutory process for marine spatial planning in the UK has been established.

Despite these positive steps, there are a number of trends that suggest vulnerabilities to climate change, and other pressures that will be exacerbated by climate change, are not reducing.

- **It is uncertain that the target for 50% of protected sites to be in a favourable condition by 2020 will be met.** Improving the condition of protected sites is an essential step in building ecological resilience to climate change. However, progress to date suggests that meeting the 2020 target will be challenging; between 2003 and 2014 the proportion of the protected network area in favourable condition declined from 44% to 38%. There is a need for greater clarity on how the target will be met, and on how 'favourable condition' is being defined. It is not apparent how the system for monitoring the condition of protected sites accounts for changes in species distributions due to climate change. Greater clarity will help ensure that meeting the target will enhance the resilience of protected sites to both climate and non-climate pressures.
- **Progress against other biodiversity targets is also off track.** Significant areas of priority habitat are being created, but not yet at a sufficient rate to meet the 200,000 hectare target by 2020. Progress is not on track to meet the target of 15% of degraded ecosystems to be under restoration by 2020. Accelerated delivery in these areas is essential, as improving the condition of protected sites alone will be insufficient to build ecological resilience and allow natural systems to accommodate climate change.
- **Internationally important peatland habitats continue to be degraded through inappropriate management.** The available evidence indicates that there has been an intensification of burning and further development of permanent tracks on sensitive upland peat habitats. Natural England is starting to require improved management practices, but intensive burning continues on internationally protected sites. A strategy for the restoration of degraded peat habitats, currently being prepared by a partnership of upland stakeholders, needs to be published and implemented.
- **Improvements in the management of farmland have not yet reversed biodiversity declines.** Long-term indicators show continuing declines in farmland biodiversity, despite the widespread uptake of agri-environment schemes. This suggests that underlying adverse pressures, including from insensitive land management practices, have not yet been effectively addressed.

Key messages

- **The majority of rivers, lakes and estuaries are failing to meet good ecological standards.** Despite reductions in pollution, only around one-quarter of surface water bodies are in a good ecological condition and this proportion has not changed significantly since 2008. Rivers, lakes and estuaries continue to suffer from persistent adverse pressures such as diffuse pollution, physical modification, over-abstraction and invasive species.
- **Coastal habitats and the marine environment continue to face deep-seated pressures.** Important coastal habitats are unable to move landwards in response to sea level rise due to the presence of hard flood defences. Significant areas of compensatory coastal habitat are being created, but the amount currently in the pipeline is insufficient to offset the expected losses. Around half of all fish stocks in UK waters are still not being managed sustainably and damaging commercial fishing practices continue. The observed decline in seabird populations in recent years is also of concern.
- **There is a need for more long-term strategic planning as to how biodiversity can accommodate future changes in climate.** Some steps are being taken, for example through landscape-scale initiatives, but a greater focus is required on identifying and safeguarding coherent ecological networks that account for observed and projected changes in the distribution of species. The new Countryside Stewardship scheme has an important role to play here.

Recommendations for further progress

- **RECOMMENDATION 26:** Defra and Natural England should continue to take action to deliver all of the outcomes in the England Biodiversity 2020 and publish within a year of this report a plan setting out how they intend to deliver key goals important for adaptation, namely:
 - improving the condition of priority habitats and protected sites (Outcome 1A);
 - increasing the extent of priority habitats by 200,000 hectares (Outcome 1B); and
 - ensuring that 15% of degraded ecosystems important for climate change adaptation and mitigation are being restored (Outcome 1D).

The action plan should also provide clarity on the interpretation of 'favourable ecological condition' in the context of climate change.

- **RECOMMENDATION 27:** Natural England, in partnership with the Upland Stakeholder Forum, should take action to deliver the widespread restoration of degraded upland peat habitats. An action plan should be published within a year of this report that includes: (a) a programme for reviewing consents for burning on protected sites; and (b) an assessment of the extent to which agri-environment schemes are being used to fund damaging practices on peatland habitats.
- **RECOMMENDATION 28:** The Environment Agency, Defra and water companies should continue to take action to ensure that water bodies are managed in ways that will increase resilience to the changes in water availability, quality and temperature expected with climate change. To deliver this (a) the Environment Agency should publish within a year of this report the steps it will take to ensure full delivery of the Restoring Sustainable Abstraction programme by 2020, and (b) Defra should press ahead with reforms to the abstraction regime early in this Parliament.

Key messages

- **RECOMMENDATION 29:** Natural England should establish within a year of this report a monitoring regime to assess the extent to which the new Countryside Stewardship scheme will help to deliver coherent ecological networks, and more broadly reduce the vulnerability of farmland wildlife to environmental pressures, including from climate change.
- **RECOMMENDATION 30:** The Environment Agency should continue to take action to ensure there is no net loss of internationally protected coastal habitats by 2025 as a result of coastal squeeze and publish within a year of this report a programme of habitat creation projects they have identified to deliver this goal. The Agency should also report on the progress being made with the implementation of the habitat creation programme in time to inform the ASC's next statutory report in June 2017.

Vision: “The natural environment, with diverse and healthy ecosystems, is resilient to climate change, able to accommodate change and valued for the adaptation services it provides.”

HM Government, 2013 National Adaptation Programme

6.1 The importance of the natural environment

England's rich wildlife and distinctive landscapes are a source of inspiration to millions of people. Many place an intrinsic value on nature and have a moral conviction that society has a duty to protect natural assets for current and future generations. In recent years, there has also been an increasing emphasis on the importance of a healthy natural environment and the wildlife that it sustains for societal well-being, and the economy.

There is a growing recognition that 'natural capital' is as vital to current and future prosperity as social and economic capital. The most recent report by the Natural Capital Committee provides a clear social and economic case for the widespread restoration of the natural environment in order to safeguard the goods and services it provides now and into the future.¹

There are 56 terrestrial, wetland and coastal habitats that are recognised as being 'of principal importance' for the conservation of biological diversity in England.² Together, these 'priority habitats' cover 1.9 million hectares, representing around 14% of England's total land area.³ Also of importance are the c.5,500 natural surface water bodies in England, comprising rivers, lakes, estuaries and coastal waters.

Around 1 million hectares of land is covered by protected site designations. Protected sites are generally the remnants of previously extensive tracts of natural habitat. Sites of Special Scientific Interest (SSSIs) are the primary type of protected wildlife site under UK legislation. Those of international importance are also designated as Special Protection Areas (SPAs) and Special Areas for Conservation (SACs) under the EU Birds and Habitats Directives respectively.⁴

¹ Natural Capital Committee (2015) *The State of Natural Capital. Protecting and Improving Natural Capital for Prosperity and Wellbeing*, <http://www.naturalcapitalcommittee.org/>

² Under section 41 of the 2006 Natural Environment and Rural Communities Act.

³ Defra (2014) *Biodiversity 2020: a strategy for England's wildlife and ecosystem services indicators*, <https://www.gov.uk/government/publications/england-biodiversity-indicators>

⁴ As well as nationally and internationally protected sites, there are also over 1 million hectares of locally important wildlife sites. These are non-statutory and protected through the land-use planning system.

6.2 Risks to the natural environment from climate change

Climate change is expected to have direct impacts on England's biodiversity. Ecological responses to the warming of recent decades are already evident.

Species can be highly sensitive to changes in environmental conditions, including climatic conditions. All species have a 'climate space' within which they can survive and reproduce. As the climate changes, the climate space of individual species will move. The ability of species to move in line with their climate space will depend on their natural dispersal capability and the availability of suitable habitat.

Some observed changes in the distribution of species in the UK can be attributed to warmer temperatures over recent decades. For example, some southern species have expanded their range by between 30 and 60 km northwards over the last 25 years.⁵ There are examples of migratory species also responding rapidly to changing climatic conditions.⁶

Changes in climate also have implications for the timing of seasonal events. There is evidence that some spring and summer events are occurring earlier in the year; for example, oak leafing is on average three weeks earlier than 100 years ago. Long-term records show similar changes in the flight times of moths and butterflies, egg-laying dates in birds, first spawning of amphibians, and fruiting of blackberries.⁷ Such changes could disrupt critical food chains.

There is a risk that some species will be unable to adapt to shifts in climate space and the timing of the seasons. This could result in a net loss of climate-sensitive species in some areas. At the same time, other areas may gain new species moving northwards. However, this will be dependent on there being an ecologically coherent network of sites and habitats in good condition to facilitate species movement and colonisation.

The combination of climate and non-climate pressures could have major impacts on the functioning of ecosystems, with potentially significant implications for the provision of key goods and services.

Climate change will combine with a range of non-climate pressures on the natural environment, including development pressures, land-use change, pollution, and resource exploitation. The first UK Climate Change Risk Assessment highlighted:⁸

- **Changes in water availability and impacts on water quality.** Warmer, drier summers could increase soil moisture deficits and incidents of low river flows. Reduction in flow levels combined with higher water temperatures would decrease oxygen supplies and increase the likelihood of harmful algal blooms. They may also lead to the concentration of harmful pollutants in water bodies. These impacts on water quantity and quality will be exacerbated during periods of drought. In the marine environment, increased water temperatures and changes in water chemistry, particularly acidification, will place further pressure on already stressed ecosystems.
- **Pests and diseases.** Low winter temperatures currently act as a climatic control on many pests and diseases that pose a risk to native wildlife and habitats. Milder, wetter winters could increase the risk from damaging pathogens, such as red band needle blight. Changed conditions may also facilitate the spread of invasive species, further threatening native species already vulnerable to other pressures.

5 Morecroft, M. & Speakman, L. (eds.) (2013) *Terrestrial Biodiversity Climate Change Impacts Report Card*, <http://www.lwec.org.uk/resources/report-cards/biodiversity>

6 For example, between 1997 and 2007 winter populations of Bewick's swan in the UK have declined by 44%. This is most likely because of 'short-stopping', where warmer conditions enable birds to remain longer at stop-over sites along their migration flyway in Germany and the Netherlands. See Morecroft and Speakman (2013).

7 *Ibid.*

8 HM Government (2012) *UK Climate Change Risk Assessment: Government Report*, www.gov.uk/government/publications/uk-climate-change-risk-assessment-government-report

- **Extreme events.** Any increase in the frequency and magnitude of heavy rainfall events, flooding, heatwaves, and droughts, could cause major damage to habitats and disrupt ecosystem functioning. Fire risk increases during hot dry years and unusually dry seasons. Large-scale fires can cause severe damage to woodlands, heathland, and grassland habitats, and the species they support.
- **Sea level rise.** Coastal habitats are directly at risk from sea level rise and coastal change, particularly when they are unable to move landwards due to the presence of hard structures such as flood defences. This process is called ‘coastal squeeze’.

In response to these risks, the Government’s National Adaptation Programme (NAP) sets four objectives for the natural environment.⁹

The objectives were identified following consultation across a wide range of stakeholders with expertise in climate change and the natural environment, including statutory conservation bodies, wildlife charities and landowner groups.

- **Objective 19:** To build the resilience of wildlife, habitats and ecosystems (terrestrial, freshwater, marine and coastal) to climate change, so as to put our natural environment in the strongest possible position to meet the challenges and changes ahead.
- **Objective 20:** To take action to help wildlife, habitats and ecosystems accommodate and smoothly transition through inevitable change.
- **Objective 21:** To promote and gain widespread uptake in other sectors of the use of adaptation measures that benefit and/or do not adversely affect the natural environment.
- **Objective 22:** To improve the evidence base, to enhance the knowledge and understanding of decision makers, land managers and others of the impacts of climate change on the natural environment and how best we can influence adaptation or accommodate change.

The NAP objectives describe important high-level principles and processes for adaptation in the natural environment. We have reviewed progress by the actions in the NAP against each objective in Section 6.4 below.

As noted in Chapter 1, the NAP objectives tend to describe processes rather than outcomes and do not always state goals against which substantive progress can be measured. Even where the 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 NAP themes. The progress being made in respect of each of these adaptation priorities is reviewed in Section 6.3.

For the natural environment, the adaptation priorities focus on the three areas where action is most needed to build ecological resilience and accommodate inevitable climate change. These priorities derive from the approach taken by the Lawton Review.¹⁰ They are as follows:

- Improving the ecological condition of terrestrial, wetland and coastal habitats, water bodies (rivers, lakes and estuaries), the farmed countryside and the marine environment.
- Increasing the extent of priority habitats.
- Planning and developing ecologically coherent networks at a landscape-scale.

⁹ HM Government (2013) *National Adaptation Programme, making the country resilient to a changing climate*, www.gov.uk/government/publications/adapting-to-climate-change-national-adaptation-programme

¹⁰ Lawton et al (2010) *Making Space for Nature: a review of England’s wildlife sites and ecological network*, <http://webarchive.nationalarchives.gov.uk/20130402151656/http://archive.defra.gov.uk/environment/biodiversity/documents/201009space-for-nature.pdf>

A cornerstone of adaptation for the natural environment is to ensure that the existing suite of priority habitats and protected sites is in a favourable ecological condition, and thus more resilient to climate change.

Habitats and protected sites in a favourable condition are more resilient to climate change than degraded sites. A protected site is deemed to be in a favourable condition if the species for which it is designated is present and the habitat is of sufficient extent and quality to support them. Protected sites in a favourable condition play an important role in providing 'stepping stones' and new areas for colonisation for species shifting their range.¹¹

The UK has signed up to an international commitment to halt the loss of global biodiversity by 2020. In England, this led to the Biodiversity 2020 strategy, with a goal stating that by 2020 90% of priority habitats are to be in favourable or recovering condition and at least 50% of SSSIs in favourable condition (Outcome 1A).¹²

Meeting these targets would do much to improve the resilience of habitats and species to current and future climate change risks, and to safeguard the continuing provision of ecosystem goods and services.

There is a lack of transparency as to how the assessment of 'favourable' ecological condition takes climate change into account.

The monitoring of SSSIs by Natural England provides metrics for assessing the condition, and trends in condition, of sites and habitats. However, it is unclear how the assessment of favourable condition takes account of observed and projected changes in species ranges and distributions in response to changing climatic conditions. This lack of clarity risks sub-optimal management decisions. Efforts may be focussed on retaining species in locations that are increasingly outside their changing 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 sites 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.

The definition of recovering condition assumes that agreed management plans will be implemented.

A SSSI that is not in a favourable condition but under a targeted agri-environment agreement is classified by Natural England as being in an 'unfavourable recovering' condition.¹³ By signing up to a targeted agri-environment scheme, the landowner is agreeing to a prescribed management regime for the site that has certainty of funding for 10 years or more. It is assumed that this management agreement will, in time, result in the site achieving favourable condition. Some 1.4 million hectares (15% of available agricultural land) were covered by targeted agri-environment schemes in 2014 including most (93%) of the SSSI network. As a result, the area of SSSIs in unfavourable recovering condition increased greatly, from 13% in 2003 to 59% in 2014.¹⁴

¹¹ For example, analysis of changing distributions of bird and butterfly species in England found that 75% of new colonisations occurred in protected sites, which only covered 14% of the area where colonisation was being recorded. See Thomas et al. (2012). Protected areas facilitate species' range expansions. *Proceedings of the National Academy of Science* (PNAS). 109, 14063-14068.

¹² Defra (2011) *Biodiversity 2020: A strategy for England's wildlife and ecosystem services*, <https://www.gov.uk/government/publications/biodiversity-2020-a-strategy-for-england-s-wildlife-and-ecosystem-services>

¹³ Defined as agri-environment schemes that are targeted towards areas of high biodiversity and environmental value, particularly SSSIs and priority habitats.

¹⁴ See: <https://www.gov.uk/government/publications/england-biodiversity-indicators>

However, having a management agreement in place does not necessarily mean that favourable condition will be achieved. Success is dependent on the continued delivery of the management prescriptions. Natural England estimated in 2011 that 62,000 hectares of SSSIs were at risk of moving into a declining ecological condition over the following 10 years due to land managers not complying with agreements or funding not being in place.¹⁵ There is a lack of transparency on the proportion of sites classed as recovering where ecological condition is improving. A clearer system for 'benchmarking' progress towards favourable condition would assist land-managers and statutory agencies alike.

The restoration of degraded ecosystems is also an important adaptation response.

Building the resilience of the natural environment to climate change will require major ecosystem restoration that goes beyond improving habitat condition. For example, restoring hydrological function to wetland habitats will be essential for resilience to projected changes in precipitation and evapo-transpiration.

The Biodiversity 2020 strategy has a goal of restoring at least 15% of degraded ecosystems as a contribution to climate change mitigation and adaptation (Outcome 1D). This is the only specific commitment to climate change adaptation in Biodiversity 2020. Improving the functioning of peatland, coastal and woodland ecosystems through restoration will enhance the delivery of services important for adaptation and mitigation, such as natural flood management and carbon sequestration.

Natural England has identified approximately 1 million hectares of degraded wetlands as potentially restorable. A 15% figure for restoration equates to around 153,000 hectares, which has been agreed as the minimum target to meet the Biodiversity 2020 goal.¹⁶

In the case of woodland habitats, the emphasis has been placed on the restoration of ancient woodlands that have been converted to coniferous forestry. The Forestry Commission is currently in the process of identifying the baseline for degraded woodlands against which to set the 15% target.¹⁷

Extending existing habitats and creating additional habitat is needed to enable species to respond to changing climate conditions.

The Lawton Review found that the current suite of protected areas in England does not constitute a coherent ecological network that will enable wildlife to be able to adapt to climate change. As well as improving the condition of protected areas, the review highlighted the need to extend existing sites and create new sites in order to deliver more ecologically coherent networks that account for projected changes in species distribution.

Biodiversity 2020 includes the goal of there being no net loss of priority habitat and an increase in the overall extent of priority habitats by at least 200,000 hectares by 2020 (Outcome 1B). On the coast, habitat regulations require compensatory habitat to be created when sites designated as being of international importance are damaged or suffer loss due to coastal squeeze.

Figure 6.1 summarises the climate hazards, contextual factors and adaptation priorities that are relevant to the natural environment, together with a summary of the actions listed in the NAP.

¹⁵ Natural England (2011) *Protecting England's natural treasures: Sites of Special Scientific Interest* (NE306), <http://publications.naturalengland.org.uk/publication/47003>

¹⁶ Data obtained from papers taken to Defra/Natural England Biodiversity Programme Board.

¹⁷ *Ibid.*

Figure 6.1: Climate hazards, contextual factors and adaptation priorities for the natural environment



Climate hazards	Contextual factors	Adaptation priorities	Relevant NAP actions
Reduced water levels/flows	Population growth Economic growth Consumer preferences Land-use change Influence of European Union policies	Ecological condition of terrestrial, wetland and coastal habitats	• Meet Biodiversity 2020 commitments (1A and 1D)
Drought		Ecological condition of rivers, lakes and estuaries	• Implement Water Framework Directive • Deliver Restoring Sustainable Abstraction Programme
Heavier rainfall		Ecological condition of farmed countryside	• Deliver Rural Development Programme for England
Sea level rise & flooding		Ecological condition of marine environment	• Establish Marine Protected Areas • Meet Biodiversity 2020 commitments • Reform Common Fisheries Policy
Higher average and extreme temperatures		Extent of priority habitats	• Meet Biodiversity 2020 commitments (1C) • Identify areas suitable for coastal habitat creation
Changes in climate space		Coherence of ecological networks	• Develop ecological networks at the landscape-scale
Changes in timing of seasonal events			
Pests and diseases			

6.3 Progress being made


This section evaluates the extent to which the actions and policies in the NAP and elsewhere are addressing the identified climate risks, following the method described in Chapter 1. Further details and the underlying evidence supporting the analysis is provided in an annex to this report available on the CCC's website.¹⁸

6.3.1. Improving ecological condition of natural assets

6.3.1a. Terrestrial habitats – woodlands, heaths and grasslands

Is there a plan?		The England Biodiversity 2020 strategy includes goals for: <ul style="list-style-type: none"> • 90% of priority habitats to be in a favourable or recovering condition. • 50% of SSSIs to be in a favourable condition. • 15% of degraded ecosystems to be under restoration.
Are actions taking place?		Actions are being taken to manage and restore terrestrial habitats, principally through agri-environment schemes. Actions in the NAP are being delivered, primarily focusing on raising awareness of climate change amongst land managers.

¹⁸ See: <http://www.theccc.org.uk/publications/>

<p>Is progress being made in managing vulnerability?</p>		<p>Progress does not appear to be on track to meet the Biodiversity 2020 strategy targets.</p> <ul style="list-style-type: none"> • By 2014, around 74% of terrestrial priority habitats by area were in a favourable or recovering condition against the 90% target. • 28% of terrestrial SSSIs by area were in a favourable condition against the target of 50%. • The area of degraded woodland to be restored to meet the 15% target has not yet been identified. • Key woodland indicator species (birds and butterflies) are in long-term decline.
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Terrestrial habitats, woodlands, heaths and grasslands, are the most widespread components of England's natural environment.

Terrestrial habitats make up nearly two-thirds (64%) of all priority habitats in England, covering nearly 1.2 million hectares. Almost one-third (31%) of the area of terrestrial priority habitats is covered by SSSI designations.¹⁹

Broadleaved, semi-natural woodlands, are the dominant type of terrestrial priority habitat, covering over 700,000 hectares. There are also around 15,000 hectares of traditional orchards remaining in England. A relatively low proportion (12%) of woodlands, and hardly any orchards (<1%), are designated as SSSIs.²⁰

Woodlands in good ecological condition are extremely valuable habitats for a wide range of species, particularly birds, butterflies, invertebrates and fungi. Ancient woodlands are arguably one of the most culturally important habitats in England. Woodlands also provide substantial recreational and amenity benefits, particularly when they are located near centres of population. Woodlands sequester approximately 18 million tonnes of CO₂ a year, making them the UK's largest carbon sink. There is also growing evidence of the valuable role that woodlands and tree planting can play in managing surface water run-off, in both rural and urban environments, thus contributing to the reduction of flood risk.²¹

Heathland habitats cover nearly 300,000 hectares, three-quarters of which are in the uplands. The majority of heaths (70%) are SSSIs, providing critical habitat for a range of specialist and rare species. Lowland heaths are, in many cases, located relatively close to population centres and so are important for recreation. Upland heaths - such as the North York Moors and Yorkshire Dales National Parks - often form iconic landscapes of high cultural and recreation value.

The remaining 140,000 hectares of terrestrial priority habitat comprise grasslands, including calcareous chalk downland, upland hay meadows, and acid grasslands. Most grasslands support livestock production, and just over half (52%) are designated as SSSIs.

The condition of terrestrial habitats has suffered from inappropriate management and deep-seated, persistent pressures. This reduces their resilience to climate change impacts.

From an ecological perspective, many terrestrial habitats have been damaged by intensive management, with for example high livestock densities leading to overgrazing. In other locations under-management is the problem, as traditional management regimes have become unviable. For example, the cessation of grazing on habitats such as chalk grassland has resulted in scrub invasion and a loss of the associated specialised wildlife.

¹⁹ See: <https://www.gov.uk/government/publications/england-biodiversity-indicators>

²⁰ *Ibid.*

²¹ For example, Forest Research's *Slowing the Flow* project in Pickering, North Yorkshire has been exploring the ability of better land-use management to help reduce flood risk by implementing increased floodplain storage, floodplain planting, and woody debris dams. See: <http://www.forestry.gov.uk/fr/slowngtheflow>

Pollution continues to be a major reason for terrestrial habitats being in poor condition. This is primarily caused by agricultural pesticides, and sulphur, nitrogen and ammonia emissions to the air. For example, critical loads of nitrogen were exceeded across 97% of the area of sensitive habitats in England between 2006 and 2008.²²

Some invasive species also have significant detrimental impacts on native wildlife. Between 1960 and 2014, the number of highly damaging invasive non-native species in terrestrial habitats increased from just under 40 species to nearly 70.²³

Terrestrial habitats in a poor condition are more vulnerable to climate change impacts. Some woodland habitats are particularly at risk from changes in soil moisture content, increased exposure to wildfire, and pests and diseases. Heathlands are also highly vulnerable to wildfire. Woodlands and some grassland habitats can be particularly vulnerable to reduced water availability.

The Biodiversity 2020 targets for improving the condition of terrestrial priority habitats and protected sites are not yet on track to be met.

Nearly three-quarters (74%) of the area of terrestrial habitats were classed as either in a favourable or recovering condition in 2014 against the target of 90% by 2020.²⁴ However, the majority (78%) of the area of broadleaved woodland habitat was not in target condition. As a result, terrestrial priority habitats are not on-track to meet the 90% target by 2020.

Only one type of terrestrial habitat (upland hay meadows) currently meets the SSSI target with more than 50% of its area in favourable condition. Overall, less than one-third (28%) of terrestrial SSSIs are currently classed as favourable, with upland heath - the largest terrestrial SSSI habitat type - falling far short of the 50% target. For most terrestrial SSSIs the proportions in favourable condition did not change significantly over the last decade, remaining at around 45% for woodland, and 40% for lowland heath. However, upland heath habitats have seen a decline, from 20% to 12% in favourable condition. Substantial effort will be required over the next five years for terrestrial SSSIs to achieve the 50% target.²⁵

The baseline area of ancient woodlands requiring restoration has not yet been identified by the Forestry Commission. As a result, no target has yet been set in terms of the area of restoration required to meet the 15% 2020 goal (Outcome 1D).

The slow progress with improving the resilience of terrestrial habitats is reflected in the long-term decline of key indicator species.

In 2013, the breeding woodland bird index in England reached its lowest recorded level, 28% below the 1970 baseline. This long-term decline has been driven mainly by a 39% decrease in specialist woodland birds.

Since 1990, butterfly numbers in woodlands have fallen by 48%, reaching a historical low point in 2012. This long-term decline is thought to be due to a lack of woodland management and loss of open spaces. However, statistical analysis of the underlying smoothed trend shows no overall change since 2008. This suggests that the declines may at least have been halted, though there is as yet no evidence of a recovery in numbers.²⁶

²² See: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/141782/iwfg30acid-eutr-201105.csv/preview

²³ 179 non-native species have been identified as the 'most invasive' in terms of having the greatest potential to impact negatively on native wildlife. See: <https://www.gov.uk/government/publications/england-biodiversity-indicators>

²⁴ *Ibid.*

²⁵ *Ibid.*

²⁶ *Ibid.*

Actions in the NAP mainly focus on increasing awareness of climate change adaptation for conservation practitioners and land managers.

Natural England has produced a number of important tools and publications to advise land managers and conservation practitioners. The 'adaptation manual' sets out detailed guidance on adaptation options for different habitat types.²⁷ A spatially-modelled, national biodiversity climate change vulnerability assessment has also been produced.²⁸ These actions, along with other similar examples in the NAP, are likely to help build resilience in time. However, the NAP does not set out how the Biodiversity 2020 targets for improving the condition of priority habitats or restoring degraded ecosystems will be met.

RECOMMENDATION 26: Defra and Natural England should continue to take action to deliver all of the outcomes in the England Biodiversity 2020 and publish within a year of this report a plan setting out how they intend to deliver key goals important for adaptation, namely:




- improving the condition of priority habitats and protected sites (Outcome 1A);
- increasing the extent of priority habitats by 200,000 hectares (Outcome 1B); and
- ensuring that 15% of degraded ecosystems important for climate change adaptation and mitigation are being restored (Outcome 1D).

The action plan should also provide clarity on the interpretation of 'favourable ecological condition' in the context of climate change.

²⁷ Natural England (2014) *Climate Change Adaptation Manual - Evidence to support nature conservation in a changing climate* (NE546), <http://publications.naturalengland.org.uk/publication/5629923804839936>

²⁸ Natural England (2014) *National biodiversity climate change vulnerability model* (NERR054), <http://publications.naturalengland.org.uk/publication/5069081749225472>

6.3.1b. Wetland habitats – peat bogs, fens and marshes

Is there a plan?	 Green	<p>The England Biodiversity 2020 strategy includes goals for:</p> <ul style="list-style-type: none"> • 90% of priority habitats to be in a favourable or recovering condition. • 50% of SSSIs to be in a favourable condition. • 15% of degraded ecosystems to be under restoration. <p>The Wetland Vision partnership has a long-term aspiration to improve the condition of wetland habitats and species.</p>
Are actions taking place?	 Amber	<p>Some restoration of wetland habitats is being delivered, including of upland blanket bog via water company catchment management programmes in partnership with wildlife charities and National Parks. Action is also being taken to phase out peat extraction from lowland raised bogs.</p> <p>However, there is evidence of more intensive and widespread burning regimes affecting sensitive peat habitats on upland grouse moors. Natural England is giving consent to burning on the majority of blanket bog SSSIs.</p>
Is progress being made in managing vulnerability?	 Red	<p>Progress does not appear to be on track to meet the Biodiversity 2020 strategy targets.</p> <ul style="list-style-type: none"> • By 2014, around 72% of wetland priority habitats by area were in a favourable or recovering condition against the 90% target. • 20% of wetland SSSIs by area were in a favourable condition against the 50% target. • The area degraded wetland ecosystems requiring restoration to meet the 15% target by 2020 has been identified. However, there is no process in place for reporting against progress. <p>The available evidence suggests that carbon losses from peatlands are increasing both as carbon dioxide to the atmosphere and in the form of dissolved organic carbon to water bodies. As well as adding to the climate mitigation challenge, there will be costs for consumers arising from drinking water treatment.</p>

England's wetland habitats provide essential goods and services, including carbon storage and the provision of clean water, and are internationally important for biodiversity.

Wetlands make up close to one-third (29%) of priority habitats in England, covering over half a million hectares.

Just over 50% of wetland habitats are peat bogs, mainly blanket bog in the uplands and raised bog in the lowlands. Bog habitats cover around 290,000 hectares, with upland blanket bog accounting for all but 10,000 hectares of this total. Some 67% of blanket bog and 85% of raised bog are designated as SSSIs. The UK is home to 13% of the global resource of blanket bog. In England blanket bog is the dominant habitat type designated for protection under the EU Habitats Directive, accounting for 25% of the total area of SACs.²⁹

29 IUCN (2011) *Commission of Inquiry on Peatlands*, <http://www.iucn-uk-peatlandprogramme.org/sites/www.iucn-uk>

A relatively small proportion of wetland habitats are categorised as lowland fen (33,000 hectares), mainly located in the east of England. These deep peat habitats are the remnants of what were once vast tracts of fenland, most of which have been drained for agriculture since the 1600s. More than half (59%) of remaining fen habitat is SSSI.³⁰

When in good condition, peat bogs and fens actively soak up carbon dioxide, accumulating between 3 and 7 tonnes of carbon per hectare per year. An estimated 140 million tonnes of carbon is stored in England's upland deep peats.³¹ Peatlands also play a vital role in the provision of water to millions of people, as they form the headwaters for some of England's major water supply catchments.

The degraded condition of many wetland habitats increases their vulnerability to climate change.

Warmer and drier conditions in the future could have implications for the viability of England's wetland habitats, particularly blanket bog. The area of suitable climate for peat forming vegetation is projected to decline in extent by between one-half and two-thirds by the 2050s. However, paleo-ecological evidence stretching back over 9,000 years shows that peat forming vegetation has adapted to warming periods in the past. This suggests that when peat habitats are in a good condition they can potentially continue to form peat even under warmer and drier climatic conditions.³²

The extensive degradation of England's blanket bog habitats suggests that they will be highly vulnerable to the impacts of climate change. A survey by Natural England in 2012 estimated that some 144,000 hectares (51%) of the 281,000 hectares of blanket bog in England has completely lost its mossy, peat-forming vegetation.³³

- **40,000 hectares (14% of the total habitat area) are completely bare of vegetation or are severely gullied.** In these areas, deep channels have formed that can often erode down to the mineral layer under the peat. Gully erosion can eventually undermine the remaining vegetation and leave a landscape of bare peat. Vegetation loss can also result from severe wildfires. Bare peat is eroded by rain, frost heave, and wind, with much of the eroded peat being carried into rivers and reservoirs.
- **50,000 hectares (18% of the total area) has been drained.** Shallow ditches (known as 'grips') have been cut across significant areas, often in response to government-funded agricultural improvement programmes in the 1960s and 1970s. The grips drain water more quickly away from the mossy surface, which thins or disappears completely as the water table lowers.
- **76,000 hectares (27%) have lost peat-forming vegetation due to regular burning.** Over the last 150 years many upland landscapes in the UK have been subject to managed burning. Most current burning is to promote a mosaic of heather of different ages. Heather is the preferred habitat for red grouse, the primary upland game bird. There are approximately 140 shooting estates in the English uplands, with an average size of 2,000 hectares. Managed burning is also used to cut fire breaks in order to reduce the spread of wildfires.

Almost all blanket bog habitat in England is affected by air pollution. This is particularly the case in the Pennines, where more than two centuries of industrial emissions and heavy metal contamination have acidified the peat and in some areas contributed to the loss of peat-forming mosses. Present-day air pollution is also an issue, including ammonia from agricultural sources.

30 See: <https://www.gov.uk/government/publications/england-biodiversity-indicators>

31 Natural England (2010) *England's peatlands: carbon storage and greenhouse gases* (NE257), <http://publications.naturalengland.org.uk/publication/30021>

32 ASC (2013) *Managing the land in a changing climate*, <http://www.theccc.org.uk/publication/managing-the-land-in-a-changing-climate/>

33 Natural England (2012) *Mapping the status of upland peat using aerial photographs* (NECR089), <http://publications.naturalengland.org.uk/publication/369581>

Significant efforts have been made to restore degraded blanket bog habitats over the last decade. These have been primarily through catchment-scale restoration partnerships, with water companies playing a prominent role.

A number of water companies operating in the English uplands have in recent years been investing in catchment-scale peatland restoration schemes. Their primary motivation is to help reduce the carbon content in raw water, and therefore lower the costs of drinking water treatment. High carbon content in raw water causes colouration, which can create carcinogenic by-products when the water is disinfected during the treatment process. When the by-products occur above an internationally agreed threshold, the drinking water is not fit for human consumption.³⁴

As reported by the ASC in 2013, an estimated £45 million was due to be invested by water companies in upland catchment management schemes between 2010 and 2015.³⁵ These include the United Utilities SCAMP project, moorland restoration in Keighley Moor by Yorkshire Water, and South West Water's Upstream Thinking initiative. With the help of this investment, restoration work is underway on an estimated 60,000 hectares of upland peat. It is likely that as much as 70% of the 85,000 hectares of gripped and gullied peat is in the process of being restored by these schemes. However, the amount of peatland restoration to be delivered by water companies over the next five years is unclear, as individual schemes are not specified within water company business plans for the new Asset Management Plan period (AMP6, 2015-2020).

Many catchment schemes are being delivered through innovative multi-agency partnerships. National Park and Area of Outstanding Natural Beauty (AONBs) authorities play a co-ordinating role in a number of these partnerships, with funding and advice from Natural England and the Environment Agency. Non-governmental organisations, such as the National Trust, RSPB and the Wildlife Trusts, also play key roles. An estimated 1,400 hectares of previously bare peat has been stabilised and is in the process of being re-vegetated through the work of these partnerships.

Agri-environment schemes are a further important mechanism for delivering peatland restoration. As noted in the ASC's 2013 report, £27 million was paid to farmers and landowners who took up moorland restoration options under the Higher Level Scheme (HLS) between 2007 and 2013. Around 200,000 hectares of deep peat in the uplands are now covered by these options, which primarily address income forgone as a result of reducing the density of livestock in sensitive areas. Many of the partnerships working on restoration will have accessed HLS funding.³⁶

Elsewhere in the uplands, the extent and frequency of burning regimes have increased across extensive areas of blanket bog, primarily as a result of grouse moor management.

There is evidence across much of northern England and indeed across Great Britain as whole that the area of burned moorland has increased significantly in recent decades. A comparison of aerial photography from the 1970s and 2000 of over 200 km² of the English uplands found that the extent of new burns had doubled (from 15% to 30%) over this period. The frequency of burns had also increased, with average repeat times falling from every 20 years in the 1970s to every 16 years in 2000.³⁷ A more recent study found that the annual number of burns between 2001 and 2011 increased significantly across Scotland, England and Wales, at an overall rate of 11% per year, with an accelerating trend in more recent years. The same study found that the percentage of moorland burned area was significantly greater within protected areas than in non-designated areas, occurring in 55% of the SACs and 63% of the SPAs assessed.³⁸

34 Disinfection of raw water is a requirement to meet drinking water standards and is not undertaken to reduce colour itself. Water companies have to physically remove the colour from the raw water, or blend it with water from reservoirs, before it can be disinfected. This is an expensive and energy intensive process requiring specialist equipment.

35 ASC (2013).

36 *Ibid.*

37 Yallop et al (2006) The extent and intensity of management burning in the English uplands. *Journal of Applied Ecology* 43, 1138–1148.

38 Douglas et al. (in press). Vegetation burning for game management in the UK uplands is increasing and overlaps with soil carbon and protected areas. Note that the study found that the SACs and SPAs with the greatest percentage areas of burning were in northern England. Of the 229,000 hectares of SAC being burnt in Great Britain, 213,000 hectares is in England (93%). For SPAs, the proportion is 90%.

The motive for increasing the extent and intensity of burning is primarily to increase grouse yields. For example, one estate in the Pennines set out plans for a ten-fold increase in yields, from an average of 456 brace per bag between 2001-2005 to 5,300 brace per bag by 2020.³⁹ There was a 29% increase in the number of gamekeepers in the north of England between 2001 and 2009. This also suggests there has been an increase in the intensification of land management practices.⁴⁰

The increasing intensity of production on grouse moors is also resulting in the construction of more permanent and semi-permanent tracks on blanket bog. Tracks can impact blanket bog processes and structure and are associated with events such as landslips, as well as more subtle hydrological changes that disrupt the active formation of peat. These impacts were confirmed in a review of the evidence by Natural England in 2013.⁴¹

There is increasing evidence that managed burning damages ecosystem function and adversely affects the provision of key services provided by peatlands.

In 2013, Natural England undertook a systematic evidence review of the impacts of managed burning on blanket bog. This found strong evidence that rotational burning changes species composition, reduces peat accumulation, causes declines in carbon storage, and results in increases of dissolved organic carbon in peatland watercourses.⁴²

A more recent review of the evidence also concluded that the benefits of rotational burning as a management tool are in most cases outweighed by the environmental impacts.⁴³

Natural England has been increasingly using agri-environment agreements to regulate managed burning on protected sites. Despite this, practices that adversely affect blanket bog habitats continue.

Since 1999 Natural England has issued a total of 150 consents allowing managed burning of blanket bog SSSIs covering an area of 160,000 hectares.⁴⁴

The number of consents rose significantly between the period 1999-2006 and 2007-2014, with 12 granted in the former period, and 138 in the latter. The rise in the number of consents is related to the launch of the Higher Level Stewardship (HLS) scheme in 2007. When landowners enter into HLS, a ten year management plan is agreed with Natural England which may allow for burning to continue.⁴⁵

It is not possible from the available data to identify the type of burning being consented through HLS agreements. Some will be fairly limited burns, such as for fire breaks or conservation purposes. Natural England has also made clear that following their 2013 evidence review, the burning of blanket bog would not normally be allowed in new agreements. Any burning that is allowed through HLS is also required to be compliant with the Heather and Grass Burning Code (2007), which has a strong presumption against burning on blanket bog habitats.⁴⁶

However, grouse shooting is the specified purpose for almost all (145 of 150) consents for burning on blanket bog SSSIs. Until such consents are reviewed, rotational burning will continue to be allowed on protected sites, including those of international importance under the EU Birds and Habitats Directives.

39 Letter from R Bannister, Walshaw Moor Estate Ltd, to Dr Helen Philips, Chief Executive, Natural England. 01/04/2011.

40 Natural England (2013) *The effects of managed burning on upland peatland biodiversity, carbon and water* NEER 004, <http://publications.naturalengland.org.uk/publication/5978072>

41 Natural England (2013) *The impacts of tracks on the integrity and hydrological function of blanket peat* NEER 002, <http://publications.naturalengland.org.uk/publication/5724597>

42 Natural England (2013) NEER 004.

43 Brown, L. et al (2014) *Effects of Moorland Burning on the Ecohydrology of river basins. Key findings from the EMBER project*. University of Leeds. http://www.wateratleeds.org/fileadmin/documents/water_at_leeds/Ember_report.pdf

44 Data provided by Natural England on 9th January 2015 following an Access to Information Request (No. 2798). Note that consents issued before 2006 would have been from English Nature, the predecessor body of Natural England.

45 Natural England (2013) *Higher Level Stewardship Handbook Fourth Edition 2013*, <http://publications.naturalengland.org.uk/publication/2827091>

46 See: <http://www.uplandsmangement.co.uk/#/documents/cjg9>

Key stakeholders in the uplands are working in partnership to develop a strategy for the widespread restoration of blanket bog, but there is a lack of clarity on how this will be implemented.

Natural England has been working with the Upland Stakeholder Forum to produce a blanket bog restoration strategy. This aims to develop a common understanding and shared commitment amongst landowners, statutory bodies, and wildlife charities, to achieve blanket bog restoration that delivers multiple outcomes. There is a commitment in the draft strategy to develop a ten-year work programme. A key action will be Natural England's review of consents affecting designated sites, with the first phase covering SACs due to be completed by December 2015. The strategy and the ten-year implementation plan are yet to be published.

Some wetland priority habitats and protected sites are a long way from meeting the Biodiversity 2020 targets. There is also limited progress with delivering the goal of restoring 15% of degraded wetland ecosystems.

Only two of the six wetland priority habitat types currently meet the 90% target for being in a favourable or recovering condition. The average across all wetland habitats is 72%, with grazing floodplain and coastal marsh both significantly lower at 37%.

Similarly, only two of the six wetland habitat types currently meet the SSSI 50% favourable target. The two types of peat bog habitat are a long way from meeting the 50% target, with only 6% of raised bog and 12% of blanket bog in a favourable condition in 2014. The area of blanket bog in favourable condition has declined in recent years, from 16% in 2003. The proportion of most other types of wetland SSIs in favourable condition has not changed significantly over the last decade, remaining at around 40% for lowland fens and 50% for grazing marsh.

Around 153,000 hectares of degraded wetland and coastal habitats have been identified as requiring restoration in order to meet the 15% target by 2020, though there is currently no process in place for reporting progress against this outcome. As noted above, restoration of upland peat has been occurring, especially of blanket bog. In the lowlands, there have been a number of projects to restore wetland habitats. Raised bogs in the Humberhead Levels and in the north-west have been undergoing extensive restoration following the gradual phasing out of peat extraction for horticultural markets. Lowland fen restoration has also been occurring, for example, in the East Anglian Fens, and in the Somerset Levels.

Overall, most wetland habitats and particularly blanket bogs are becoming more vulnerable to climate change impacts. This is putting vital carbon stores at risk. The NAP makes little reference to the need for widespread peatland restoration as a priority for adaptation.

The amount of carbon lost to water bodies has increased, with levels of dissolved organic carbon (DOC) in water courses having doubled over the last 30 years. This is the single largest change in upland water quality over the period.⁴⁷ Concentrations of DOC have shown linear increases at all 22 sites covered by the UK Upland Water Monitoring Network established in 1988. Some of this observed increase in DOC is likely to be due to reductions in sulphur deposition (more commonly known as acid rain) since the 1990s. However, there is some evidence that in parts of the English uplands the expansion in extent and frequency of managed burning is the primary cause.⁴⁸




⁴⁷ UK National Ecosystem Assessment (2011) *Synthesis of key findings*, <http://uknea.unep-wcmc.org/Resources/tabid/82/Default.aspx>

⁴⁸ Clutterbuck and Yallop (2010) Land management as a factor controlling dissolved organic carbon release from upland peat soils 2: Changes in DOC productivity over four decades. *Science of the Total Environment* 408, 6179–6191

There are some actions in the NAP that are directly relevant to peatland restoration. One is to pilot the Peatland Code, a new approach to securing investment in restoration by private companies in order to trade in the carbon savings delivered. Such an approach could make a significant contribution to the restoration effort, though it is too early to assess its potential success. Beyond this, there is relatively little reference in the NAP given to the importance of restoring degraded wetland habitats.

RECOMMENDATION 27: Natural England, in partnership with the Upland Stakeholder Forum, should take action to deliver the widespread restoration of degraded upland peat habitats. An action plan should be published within a year of this report that includes (a) programme for reviewing consents for burning on protected sites; and (b) an assessment of the extent to which agri-environment schemes are being used to fund damaging practices on peatland habitats.

6.3.1c. Coastal habitats – saltmarsh, mudflats, dunes, shingle beaches, sea cliffs, lagoons

Is there a plan?		The England Biodiversity 2020 strategy includes goals for: <ul style="list-style-type: none"> • 90% of priority habitats to be in a favourable or recovering condition. • 50% of SSSIs to be in a favourable condition. • 15% of degraded ecosystems to be under restoration.
Are actions taking place?		Appropriate management is being delivered for the majority of coastal habitats, with action being taken to improve habitat condition.
Is progress being made in managing vulnerability?		Coastal habitats are on course to meet the Biodiversity 2020 targets. <ul style="list-style-type: none"> • By 2014, 82% of coastal priority habitats were in a favourable or recovering condition by area against the 90% target. • 57% of coastal SSSIs were in a favourable condition by area against the 50% target.

Coastal habitats are the smallest habitat type by area but are extremely valuable for wildlife. They also provide a range of vital services, including protection from coastal flooding and storm surges.

Coastal habitats make up around 7% of the total area of priority habitat in England, covering an area of 130,000 hectares. They fall into two broad categories: inter-tidal (between the mean and high water mark), and supra-tidal (above the high-water mark but still within the coastal zone).

Inter-tidal habitats (saltmarsh and mudflats) make up the majority of coastal priority habitat. There are nearly 25,000 hectares of saltmarsh and 78,000 hectares of mudflats, mostly located in estuaries, with nearly all (93%) covered by SSSI designations. No other habitats have such a high level of designation.

Supra-tidal habitats are more varied, including 11,000 hectares of sand dunes, 11,000 hectares of cliffs, 4,000 hectares of shingle beaches and around 1,000 hectares of saline lagoons. These habitats also have high proportions designated as SSSIs, ranging from 90% of shingle beaches to 66% of cliffs.⁴⁹

49 See: <https://www.gov.uk/government/publications/england-biodiversity-indicators>

The greatest pressure faced by coastal habitats is sea level rise, though physical damage, land-use change and pollution have all been significant causes of degradation.

Coastal habitats have suffered some loss and damage in recent decades through development and inappropriate management. Some supra-tidal habitats, especially sand dunes, have been afforested or converted for recreation, such as for golf courses. Inter-tidal habitats are sensitive to pollution and there are instances of saltmarsh vegetation suffering from die-back.




Coastal habitats are also highly vulnerable to sea level rise. Up to 80% of coastal habitats are at risk of coastal squeeze - unable to adapt naturally to sea level rise because they are blocked from moving landwards by hard sea defences.⁵⁰ Intertidal habitats are particularly vulnerable to being permanently submerged. As well as being extremely important for wildlife, these habitats play an important role in buffering sea defences from waves and storm surges.

Action is being taken to introduce appropriate management to coastal habitats. More effort will be needed in the next five years to deliver the 90% target. However the 50% target for SSSIs is already being met.

While only saltmarsh out of the six coastal habitat types currently exceeds the 90% target, over 80% of mudflats and shingle beaches are also in favourable or recovering condition. The average performance across coastal habitat types, with 82% classified as favourable or recovering, is higher than for terrestrial and wetland habitats.

At 57%, the proportion of coastal SSSIs in favourable condition is also much higher than for other habitat types. Most exceed the 50% target, though sand dunes are a significant exception, with only 29% of SSSIs currently in favourable condition.⁵¹

6.3.1d. Water bodies - rivers, lakes, estuaries, coastal waters

Is there a plan?		European legislation, primarily in the form of the Water Framework Directive, provides for a coherent and long-term approach to improving water quality and flows.
Are actions taking place?		<p>Strategic implementation of the Water Framework Directive is established through the River Basin Management Plan process, with delivery on the ground primarily by water companies.</p> <p>Action is being taken to improve water levels in the most vulnerable catchments through the Environment Agency's Restoring Sustainable Abstraction programme. Catchment-scale approaches to water management are becoming more widespread.</p>
Is progress being made in managing vulnerability?		<p>The water quality of rivers, lakes and estuaries has improved in recent decades. However, the ecological condition of water bodies has not shown signs of further improvement since 2008.</p> <p>A number of persistent and deep-seated pressures remain on the water environment, particularly from agriculture. Further progress is needed if water bodies are to be sufficiently resilient to climate change. Key to this will be reforming the water abstraction licensing regime.</p>

⁵⁰ ASC (2013).

⁵¹ See: <https://www.gov.uk/government/publications/england-biodiversity-indicators>

Improving the condition of surface water bodies - rivers, lakes and estuaries - is vital for aquatic species to adapt to changing climatic conditions and for the continued provision of key services, particularly clean water.

There are around 5,500 natural surface water bodies in England, principally comprising rivers, lakes, estuaries and coastal waters. These water bodies provide important economic goods and services most notably clean water but also recreation and fisheries. They are also some of the most bio-diverse habitats in England.

Water bodies are particularly sensitive to changes in climatic conditions. It is likely that river flows will become more variable, with higher high flows and lower low flows. Both extremes can have significant adverse impacts on water quality.

- **Low flows**, when combined with higher water temperatures, decrease oxygen supplies available for aquatic habitats and increase the likelihood of harmful algal blooms. They can also lead to the concentration of harmful pollutants. These impacts are exacerbated during drought events.
- **High flows** can result in the ‘flushing’ of pollutants and the erosion and deposition of sediments. This can cause spikes in pollution, for example from agricultural nutrients, as well as increases in sedimentation or in dissolved organic carbon. Increased storm events, especially in summer, could also result in more frequent overflows from combined foul and surface water sewers.

There is a range of legislation in place to protect and enhance the water environment.

The primary driver for improving the ecological condition of the water environment is the EU Water Framework Directive (WFD), which has been in place since 2008.⁵² This requires the assessment of surface water bodies in England on a six-year rolling programme. Water bodies have been assigned to 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 not be in good ecological status.

Surface water bodies face a number of deep-seated and persistent pressures that adversely affect their ecological condition.

There are four broad causes for water bodies failing to meet good ecological status:⁵³

- **Pollution from diffuse sources**, which accounts for around one-third of all failures to meet good ecological condition. Nitrates, phosphate and ammonia are the main pollutants affecting water bodies from diffuse sources, with the leaching of nitrogen fertilisers into water courses from farmland a particular issue of concern.
- **Point source pollution**, primarily from sewer discharges, account for a similar proportion of failures as diffuse sources. By definition, the issues are easier to resolve at their source than diffuse pollution, although the cost of measures to reduce pollution can be substantial.
- **The physical modification of water bodies**, for drainage or flood protection purposes, with consequences for ecological condition, through for example blocking fish migration. More than 50% of rivers in England and Wales have been physically modified, and over two-fifths of floodplains (42% by area) have been isolated from their rivers.⁵⁴

⁵² Other regulatory drivers important for water quality include Drinking Water Protected Areas, Bathing Water Directive, Shellfish Water Directive, Nitrates Directive and Urban Wastewater Treatment Directive. These together identify ‘protected areas’ from a water quality perspective which are a priority for WFD implementation.

⁵³ AECOM (2015) for the ASC.

⁵⁴ UK National Ecosystem Assessment (2011) *Chapter 9: Freshwaters – Openwaters, wetlands and floodplains*, <http://uknea.unep-wcmc.org/LinkClick.aspx?fileticket=AzwOPVXaIXA%3D&tabid=82>

- **Over-abstraction of water**, which can be exacerbated by periods of low rainfall. The Environment Agency estimates that 13% of all rivers in England are at risk of not meeting good ecological status due to over-abstraction.⁵⁵

Implementation of the Water Framework Directive is co-ordinated at a strategic scale by the Environment Agency and is primarily delivered on the ground by water companies.

The WFD sets out a process for strategic delivery through River Basin Management Plans (RBMPs). These contain an agreed programme of measures to address the causes of poor water quality in each of the ten River Basin Districts in England. The RBMPs are produced on a six-yearly cycle, with the first published in 2009. The Environment Agency has consulted on the second cycle, which will be published later in 2015.⁵⁶

The NAP describes a number of actions that are being undertaken to implement the WFD and improve the resilience of the freshwater environment to climate change.

Water companies are the primary actors implementing measures to improve water quality and the management of water bodies. All eighteen water companies in England and Wales have made commitments in their latest business plans for AMP6. These include ensuring compliance with drinking water quality standards and a target of zero serious pollution incidents.

Ofwat's final determination for AMP6 included allowing water companies to fund £3.3 billion of environmental improvements through a National Environment Programme. This includes £1 billion of investment by nine companies in measures to help implement the Water Framework Directive over AMP6.⁵⁷

Progress is being made with restoring sustainable abstraction levels for those water bodies at the highest risk, but longer-term reform of the abstraction licencing regime is required.

Reducing the amount of water taken from water bodies, or managing the timing of abstractions so to reduce environmental damage, is a key adaptation action to enhance the resilience of water bodies to climate change.

Only two of eighteen water companies plan to increase the amount of water they will abstract over the next five years. Some companies, for example Southern Water, have committed to reduce abstraction by 1.4% despite a projected 4.4% increase in population in the area they cover by 2020.⁵⁸

Ofwat encourages water companies not to take water from sensitive water bodies through an Abstraction Incentive Mechanism (AIM). However, some water companies are yet to deliver the commitments to reduce abstraction contained in their 2010-2015 Business Plans, and only one-third of companies are fully implementing the AIM.⁵⁹

The Environment Agency's Restoring Sustainable Abstraction programme has identified nearly 500 abstraction licences that are causing particular problems for protected sites (SSSIs, SACs and SPAs). Around 80% of these licences were for public water supply or agricultural abstractions. By March 2015 nearly half of the licences (211 out of 464) had been reviewed, leading in many cases to a reduction in licence volumes or the introduction of conditions to restrict abstraction during times when water is scarce. One-fifth of licences have been revoked.⁶⁰ Public water supply licences make up 60% of those yet to be reviewed, and licences for agricultural abstraction account for about one-third. The latter are

⁵⁵ Environment Agency (2013) *Managing water abstraction*, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/297309/LIT_4892_20f775.pdf

⁵⁶ Environment Agency (2014) *Update to the draft river basin management plans*, <https://www.gov.uk/government/consultations/update-to-the-draft-river-basin-management-plans>

⁵⁷ Figures provided by Ofwat.

⁵⁸ Figures provided by Ofwat.

⁵⁹ Blueprint for Water (2014) *Blueprint for PR14: An environmental assessment of water company plans*, http://www.wcl.org.uk/docs/Blueprint_for_PR14_Assessment.pdf

⁶⁰ Figures provided by the Environment Agency.

some of the most difficult to amend due to the potential impact on farming incomes. The Agency aims to complete the programme by 2020.⁶¹

In the longer-term there is a need to reform the water abstraction licencing regime to allocate water more efficiently between different sectors. The new regime needs to establish a pricing framework that is more responsive to changes in water scarcity, and that safeguards the natural environment. The Government has committed to reform the system and is due to announce its plans early in this Parliament.

Catchment management approaches are increasingly being rolled out across the country.

The water environment is affected by activity that takes place on land as well as through the abstraction, use and return of water to rivers, the sea and the ground. River catchments are seen as the natural landscape-scale at which to coordinate action by all those who use water or influence land management.

A catchment management approach is recognised by Defra, the Environment Agency and water companies as particularly important for addressing diffuse pollution from both agricultural and urban sources. Defra's policy aspiration is for all of the c.80 catchments in England to have a catchment management partnership in place, although no deadline has been set by when this should be achieved.⁶²

Water companies intend to invest £206 million in catchment management schemes between 2015 and 2020. Proposed activities include the provision of advice and grants to farmers, and capital investment in restoring degraded habitats.⁶³

Despite the actions being taken, the ecological condition of surface water bodies has not improved in recent years.

The proportion of all surface water bodies meeting good ecological status remained at around 23% between 2008 and 2012.⁶⁴

There is evidence of a decline in water quality in some water bodies over this period. Around 20% of rivers were classed as in poor or bad ecological status in 2012, compared to 17% in 2008. Similarly, the proportion of lakes in poor or bad condition has increased, from around 10% to just below 20% over the same time period. The trends for estuaries and coastal waters are more positive, with the proportion in good condition having increased from around 20% in 2008 to nearly 25% in 2012.⁶⁵

Overall, the lack of significant improvements in water quality since 2008 suggests that persistent and underlying pressures are not yet being adequately addressed. This is particularly the case for diffuse pollution from agriculture and the physical modification of water bodies. Both of these issues are technically difficult and potentially costly to manage, with implications for farming livelihoods. However, it is unlikely that water bodies in England will be resilient to climate change impacts if these pressures are not addressed.

61 Figures provided by the Environment Agency.

62 Defra (2013) *Catchment based approach: Improving the quality of our water environment*, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/204231/pb13934-water-environment-catchment-based-approach.pdf




63 Figures provided by Ofwat.

64 See: <https://www.gov.uk/government/publications/england-biodiversity-indicators>

65 *Ibid.*

RECOMMENDATION 28: The Environment Agency, Defra and water companies should continue to take action to ensure that water bodies are managed in ways that will increase resilience to the changes in water availability, quality and temperature expected with climate change. To deliver this (a) the Environment Agency should publish within a year of this report the steps it will take to ensure full delivery of the Restoring Sustainable Abstraction programme by 2020, and (b) Defra should press ahead with reforms to the abstraction regime early in this Parliament.

6.3.1e. The farmed countryside

Is there a plan?		Agri-environment schemes provide many of the components of a plan, though as yet there is no coherent strategy to improve the ecological condition of the farmed countryside over the long-term.
Are actions being taken?		There is widespread and increasing uptake of agri-environment schemes by farmers and land managers. Such schemes now cover the majority of agricultural land.
Is progress being made in managing vulnerability?		Despite growth in agri-environment schemes, most long-term indicators show continuing declines in species diversity in the farmed countryside.

The way farmland is managed directly affects the ability of wildlife to respond to climate change.

Environmentally-sensitive management of forests and farmland is essential if healthy populations of diverse species are to be maintained with climate change. Wildlife-friendly measures include planting and maintaining hedgerows, retaining buffer strips around the edges of agricultural fields, creating and maintaining ponds, and managing woodlands on farms.

The primary mechanism for encouraging environmental land management is the programme of agri-environment schemes funded under the EU Common Agricultural Policy (CAP).

Voluntary agri-environment schemes provide payments to land managers for income foregone as a result of the adoption of specified environmental measures. Environmental Stewardship, administered by Natural England, has been the primary agri-environment scheme since 2007.

Environmental Stewardship is split into two programmes. The Entry Level Scheme (ELS) promotes whole-farm approaches with prescriptions designed to provide basic environmental protection and enhancement. The ELS is open to any land holder on a voluntary basis, and has been a popular option for farmers since it was first piloted in 2003. The area of agricultural land under ELS reached 6.5 million hectares in 2013, 72% of all available farmland in England.

High priority ELS options have also been introduced to help reverse wildlife declines (for example amongst farmland birds), to enhance the resilience of soils and water, and to contribute to climate change adaptation and mitigation. In 2014, 1.6 million hectares of land was under these priority options, accounting for 17% of available farmland in England. This had increased from 479,000 hectares in 2011.

The Higher Level Scheme (HLS) applies a further level of prioritisation and targeting, and is aimed towards areas of high biodiversity and environmental value, particularly SSSIs and non-designated priority habitats. Land holders apply to Natural England for inclusion and their application is scored against a number of environmental criteria. Some 1.4 million hectares (15% of available agricultural land) was covered by HLS in 2014.⁶⁶

Funding allocated to agri-environment schemes will not be increased in the next round of the CAP.

The current Environmental Stewardship programme is in the process of being revised as part of the next round of the CAP, which will run up to 2020/21. In the last round (2007 to 2013), £2.6 billion of CAP funding was allocated to the Rural Development Programme for England (RDPE). The UK Exchequer added an additional £1.2 billion, giving a total budget of £3.8 billion. Some 80% of this was used to fund Environmental Stewardship.⁶⁷

In December 2013 the Government decided to transfer 12% of the total CAP budget (around £20 billion) to the next RDPE instead of the full 15% allowable under CAP rules. The 12% transfer means the total amount of funding available for agri-environment remains at a similar level to the previous round. However, as the ASC noted in a policy note published in 2013, the pace of habitat restoration needs to increase to achieve the Government's biodiversity goals for 2020.⁶⁸

The continued decline of priority species in the farmed countryside suggests that agri-environment schemes have had a limited impact to date in reducing the vulnerability of biodiversity to current and expected future environmental pressures.

The scale of species declines is highlighted by the 2013 State of Nature report. This concluded that 60% of the species for which data are available have declined over recent decades, 31% strongly so.⁶⁹ Defra's biodiversity indicators show that 75% of priority species are in long-term decline. Records going back to the 1970s for key indicator species show declines in the abundance of 56% of farmland bird species, 93% of habitat specialist butterflies, 44% of land snails and 89% of flowering plants.⁷⁰

These trends strongly suggest that the uptake of environmentally sensitive management across the farmed landscape is not yet sufficient to address the vulnerability of wildlife to current environmental pressures. Climate change is likely to add to these, and there is a pressing need for more action to build resilience if farmland wildlife is to be able to thrive and adapt.

RECOMMENDATION 29: Natural England should establish within a year of this report a monitoring regime to assess the extent to which the new Countryside Stewardship scheme will help to deliver coherent ecological networks, and more broadly reduce the vulnerability of farmland wildlife to environmental pressures, including from climate change.

66 See: <https://www.gov.uk/government/publications/england-biodiversity-indicators>




67 See: <https://www.gov.uk/government/consultations/common-agricultural-policy-reform-implementation-in-england>

68 See: <http://www.theccc.org.uk/2013/12/20/why-pay-farmers-to-protect-birds/>

69 See: <https://www.buglife.org.uk/campaigns-and-our-work/campaigns/state-nature-report>

70 *Ibid.*

6.3.1f. The marine environment

Is there a plan?		Marine conservation policy frameworks that account for long-term climate change are now in place, through European and national legislation. There are specific measures in the Biodiversity 2020 strategy for England that, if implemented, will significantly improve the resilience of the marine environment to climate change.
Are actions taking place?		The extent of England's inshore waters given protected status has increased by over 250% since 2011, albeit from a low base. A programme of measures for implementation of the Marine Strategy Framework Directive is being finalised. Some NAP actions have been delayed, including the preparation of adaptation plans by key organisations in the marine sector.
Is progress being made in managing vulnerability?		It is too early to assess the effectiveness of marine policies, although some trends suggest vulnerability may be reducing. These include improvements in the sustainability of commercial fishing, and reductions in levels of pollution and nutrient enrichment of marine waters.

Projected changes to water temperature, acidity and primary productivity are all likely to have implications for marine biodiversity and the productivity of fisheries.

Marine climate change impacts are monitored on a regular basis through the Marine Climate Change Impacts Programme (MCCIP). The most recent report card in 2013 highlighted that sea and air temperature records in UK waters continue to show an upward trend, notwithstanding short-term variability.⁷¹

The MCCIP report shows that some marine species are responding to observed temperature changes. 27 warm-adapted species increased in abundance whilst nine cold-adapted species decreased. Some species are moving northwards into UK waters as increasing sea temperatures provide more suitable conditions.

The UK's marine environment has been widely impacted by human activities.

The main human-induced pressure is commercial fishing, with examples of extreme impacts including the collapse of the North Sea herring population in the 1970s and the effective disappearance of the common skate from the Irish Sea. Fishing gear can also impact significantly upon marine habitats and species. Towed dredges (e.g. for scallop) and beam trawls can alter seabed structure resulting in loss of benthic (sea-bed) habitats. Net fishing can result in the bycatch of seabirds or non-target fish species.⁷²

Pollution is a further significant pressure on the marine environment, though problems with contaminants tend to remain relatively local to the sources and have been historically concentrated in industrialised coastlines and estuaries. The extent of oil spills varies widely from year to year and unless there is a major spill, the impact is relatively minor. In 2012 the combined index of six of the most hazardous substances being emitted to the UK marine environment was 62% lower than in 1990.⁷³

Eutrophication, mainly stemming from nutrients discharged from agriculture and sewage treatment plants, has a significant impact on water quality in some estuaries and coastal waters where water circulation is restricted.⁷⁴

71 See: <http://www.mccip.org.uk/annual-report-card/2013/>

72 Natural England (2009) *Sea fisheries: steps to sustainability*, <http://publications.naturalengland.org.uk/publication/35040>

73 See: <https://www.gov.uk/government/publications/england-biodiversity-indicators>

74 See: <https://consult.defra.gov.uk/marine/msfd-programme-of-measures>

Non-indigenous species introduced into UK marine waters can have adverse impacts on native biodiversity, though the risks are not well understood. More information is needed to better understand their abundance, distribution, and pathways of introduction.⁷⁵

Policies for protecting and enhancing the marine environment are in place at both the EU and national level.

The EU Marine Strategy Framework Directive (MSFD) requires member states to take measures to achieve or maintain Good Environmental Status (GES) for European seas by 2020. The Government has recently consulted on a programme of measures to meet this objective for UK waters

The 2009 Marine and Coastal Access Act requires the Government to establish a network of Marine Protected Areas (MPAs). These protect a representative range of habitats and species in England's seas. The Act includes powers to designate Marine Conservation Zones (MCZs) that will complement other types of MPAs, such as SSSIs, SPAs and SACs.

The England Biodiversity 2020 strategy includes a vision for 'clean, healthy, safe productive and biologically diverse oceans and seas'. There are three specific aspirations in the strategy:

- By the end of 2016, in excess of 25% of English waters are to be covered by a well-managed Marine Protected Area network.
- By 2020, fish stocks will be managed and harvested sustainably.
- By 2022 marine plans will be in place covering the whole of England's marine area.

The NAP contains a number of actions relevant to the implementation of the above measures. Most of these actions have been completed or are on-track. The Marine Management Organisation and the commercial fishing industry body, Seafish, are yet to publish voluntary adaptation plans, though they intend to do so later in 2015.

The target of 25% of English waters having protected area status is on-track to be met, although climate change has not been explicitly considered in the identification of areas for designation.

The area of protected marine sites has increased substantially, by more than 276% between 2010 and 2014. 1.1 million hectares are now protected, representing about 21 per cent of England's inshore waters (classified as within 12 nautical miles of the coast). A major factor has been the designation of marine sites under the Birds and Habitats Directives, and there are now 44 SACs and 43 SPAs in English waters. SACs protect habitats such as reefs, shallow sandbanks and intertidal mudflats, and species such as seals. The SAC network is considered to be complete. SPAs protect rare and vulnerable birds and migratory birds. The Government plans to complete the identification of SPAs by the end of 2015.⁷⁶

In 2013, the Government designated 27 MCZs (150,000 hectares within inshore waters and 819,000 hectares in off-shore waters). Consultation has recently been completed on a second tranche of MCZs and, if designated, these will cover a further 250,000 hectares of inshore waters and 830,000 hectares of offshore waters.

It is anticipated that the planned additional SPAs and MCZs designations will deliver the 25% target by 2020. However, it is not clear whether consideration has been given to the potential implications of climate change in the identification of MPA designations. The MCCIP is due to publish a 'special topic' report focussing on Climate Change and Marine Protected Areas later in 2015. This will be an

⁷⁵ *Ibid.*

⁷⁶ *Ibid.*

opportunity to review the extent to which the MPAs provide a coherent network for marine species to adapt to changing climatic conditions.

Reforms have been made to the EU Common Fisheries Policy. These aim to achieve sustainable use of fish stocks and a healthy marine environment.

The Common Fisheries Policy (CFP) is the principal legal mechanism for managing fish stocks in EU waters and its implementation should play a critical role in achieving and maintaining Good Environmental Status. The CFP is designed to ensure consistency of fishing practices across European waters, including with reference to gear selection, spatial restrictions, eliminating discards and limits on landings.

Reforms to the CFP have been agreed by Member States. These include a target of managing stocks at the Maximum Sustainable Yield (MSY), by 2015 where possible, and by 2020 in all cases. If implemented, this will help to ensure the long-term sustainability of UK fish stocks. From 2014, the setting of annual quotas (known as Total Allowable Catches) is required to take MSY into account. The Government also consulted in early 2015 on proposals to put an end to the practise of discarding unwanted dead fish back into the sea.⁷⁷

A statutory process of marine spatial planning has been introduced and is in the process of being implemented.

The UK's marine planning system, incorporating a new licensing regime, was set up under the 2009 Marine and Coastal Access Act. Marine plans set policies to achieve sustainable development in UK waters, in line with the framework established by the UK Marine Policy Statement (adopted by all four UK administrations in 2011).⁷⁸ One of the core aims of marine planning is to manage human impacts on marine ecosystems so that they can continue to provide essential goods and services.

In England, the East Inshore and Offshore Plans were adopted in April 2014. These contain policies relevant to climate change. Plans for the South Inshore and Offshore area are currently being developed. The process of plan development includes a significant level of evidence gathering and analysis, allowing for climate change risks and opportunities to be identified and action to be specified within marine plans as appropriate. Progress is on-track to complete all 11 marine plans in England by 2021.

It is too early to assess whether the emerging policy initiatives are successfully managing the vulnerability of the marine environment to climate change. Some indicators are heading in the right direction.

The MSFD has established a marine monitoring programme similar to that established for surface water bodies by the Water Framework Directive. Over the next five years the MSFD indicators will show whether Good Environmental Status is being achieved in UK waters.

In the interim, some existing indicators are moving in the right direction, although there are also concerning trends that need to be monitored.

- **Fish:** Reduction in fishing pressure has led to improvements in the status of some fish stocks. The proportion of fish stocks harvested sustainably has risen from between 7% and 29% in the 1990s to between 21% and 50%.⁷⁹ 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.




⁷⁷ Defra (2015) *Consultation on implementing the landing obligation in England for demersal fisheries*, <https://consult.defra.gov.uk/fisheries/demersal-landing-obligation-in-england>

⁷⁸ See: <https://www.gov.uk/government/publications/uk-marine-policy-statement>

⁷⁹ See: <https://consult.defra.gov.uk/marine/msfd-programme-of-measures>

- **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.⁸⁰ Grey seals are generally experiencing few problems and populations are increasing in the Humber estuary. The conservation status of the 28 species of cetaceans regularly found in UK waters is classed as favourable.⁸¹
- **Seabirds:** Although numbers of seabirds breeding in the UK had increased from the 1960s to the end of the 1990s, recent downward trends in breeding success are of concern. The main pressures on seabirds arise from fishing but pressures from non-indigenous species, hazardous substances, habitat loss, litter and visual disturbance are also recognised.

6.3.2. Extent of priority habitats

Is there a plan?		The England Biodiversity 2020 strategy includes a target for there to be no net loss in any type of priority habitat, and to increase the overall extent of priority habitats by 200,000 hectares. Habitat Regulations require the creation of compensatory habitat for designated European sites being lost due to coastal squeeze.
Are actions taking place?		Actions are being taken towards meeting the Biodiversity 2020 target and the requirements of the Habitat Regulations.
Is progress being made in managing vulnerability?		Significant areas of priority habitat are being created, but not yet at a sufficient rate to meet the 2020 target. The amount of inter-tidal habitat creation currently planned is unlikely to compensate for projected losses by the mid-2020s.

Priority habitats have been much reduced, and are severely fragmented

There have been dramatic reductions in the area of priority habitat in England since the second world war. Expansion in agricultural production saw the area of land under crops in England increase by 40% between 1940 to 1980, with extensive areas of habitat converted or modified. It is estimated, for example, that 97% of semi-natural grasslands in England and Wales were lost between 1930 and 1984 through intensification or conversion to arable land.

Habitat loss has frequently been accompanied by fragmentation, with the relatively small size of many remaining habitat patches increasing their vulnerability - and that of their dependant species - to a range of environmental pressures including climate change. Only around 4% of the 1.9 million hectares of priority habitat in England today form coherent and continuous tracts, mostly in the uplands.⁸² 77% of SSSIs in England cover an area of less than 100 hectares.⁸³

There is an aspiration to avoid a net loss in any type of priority habitat, and to deliver an increase in the overall extent of priority habitats by 2020.

The England Biodiversity 2020 strategy includes the goal of there being no net loss in any type of priority habitat, and to increase the overall extent of priority habitats by at least 200,000 hectares by 2020 in comparison to the 2011 baseline (Outcome 1B).

On the coast, the Habitat Regulations require compensatory habitat to be created when sites designated as of international importance are damaged or lost due to coastal squeeze.

⁸⁰ *Ibid.*

⁸¹ *Ibid.*

⁸² ASC (2013).

⁸³ Natural England (2011) *Protecting England's natural treasures: Sites of Special Scientific Interest* (NE306), <http://publications.naturalengland.org.uk/publication/47003>

Progress is being made in increasing the extent of priority habitats, although it is unlikely that the Biodiversity 2020 target will be met unless action is accelerated.

Since the publication of the Biodiversity 2020 strategy in 2011, 60,000 hectares of new priority habitat has been created. The majority of this (40,750 hectares) comprises arable habitat such as field margins. A further 6,500 hectares is accounted for by new woodlands. The remainder consists of new heathlands, orchards and coastal habitats created by HLS options.⁸⁴

A further 27,000 hectares of new woodland is envisaged, mainly from the Woodland Grant Scheme administered by the Forestry Commission with funding from the Rural Development Plan for England. New priority habitat is also being created in urban areas by green infrastructure projects, and new heathland habitat through the restoration of quarry and mineral workings.

If the average rate of habitat creation since 2011 is maintained (i.e. around 15,000 hectares a year) then the total delivered by 2020 will be around 150,000 hectares. Whilst progress is being made, it is likely that the Biodiversity 2020 target of 200,000 hectares will be missed.

Significant progress is being made in creating compensatory habitat on the coast. However, more will be needed to avoid a net loss of inter-tidal habitat by the mid-2020s.

The Environment Agency estimates that around 1,200 hectares of inter-tidal habitat and a further 500 hectares of freshwater habitat will be lost due to coastal squeeze by the mid-2020s.⁸⁵

Over 800 hectares of inter-tidal habitat has been, or is in the process of being, created under the Environment Agency's habitat creation programme. This will compensate for nearly 70% of the projected losses. A further 700 hectares has been identified for potential creation, although plans are not in place as to how these projects will be delivered. If they fail to materialise, then the requirement under the Habitat Regulations to compensate for losses of inter-tidal habitat caused by coastal squeeze will not be met.

There are also notable regional differences in the level of inter-tidal habitat creation. The rate of new habitat creation in the Thames and Severn estuaries is well below the projected regional losses. A high proportion (43%) of the total amount of inter-tidal habitat created to date in England (800 hectares) has been in the Humber estuary, although even here some parts of the estuary are projected to experience net losses.

The picture for wetland sites on the coast is more positive. 770 hectares of reedbeds and coastal grazing marsh have been created, which more than compensates for the 500 hectares projected to be lost by the mid-2020s. As a further 220 hectares is also potentially deliverable, it is very likely that there will be a net increase in the extent of wetland habitats in coastal areas over the next decade or so.⁸⁶

The Environment Agency is no longer producing annual updates on its habitat creation programme, with the most recent report being in 2012/13 (on which the above numbers are based). It is not clear how the Agency intends to report in the future on whether it is on-track to compensate for projected habitat losses.




⁸⁴ Data obtained from papers taken to Defra/Natural England Biodiversity Programme Board.

⁸⁵ Environment Agency (2013) *National Annual Review of Habitat Creation Programmes – England*. Progress report to March 2013.

⁸⁶ *Ibid.*

RECOMMENDATION 30: The Environment Agency should continue to take action to ensure there is no net loss of internationally protected coastal habitats by 2025 as a result of coastal squeeze and publish within a year of this report a programme of habitat creation projects they have identified to deliver this goal. The Agency should also report on the progress being made with the implementation of the habitat creation programme in time to inform the ASC's next statutory report in June 2017.

6.3.3. Coherence of ecological networks

Is there a plan?		The Natural Environment White Paper introduced a programme to promote Nature Improvement Areas (NIAs) - large, discrete areas where a local partnership has a shared vision to deliver a 'step change' in nature conservation. NIAs could add significantly to ecological coherence, but at present only cover around 3% of England's land area.
Are actions taking place?		12 NIAs were established in 2012, supported by Defra funding for a three year period. Actions in the NAP have been delivered which primarily relate to embedding climate change in the NIAs, and in other landscape-scale initiatives, such as those being delivered by the RSPB, Wildlife Trusts and Woodland Trust.
Is progress being made in managing vulnerability?		There is no long-term security of funding for the NIAs and the impact of dedicated funding coming to an end is unclear. Landscape-scale initiatives promoted by conservation charities are helping, but are resource constrained. There is currently no national strategy for identifying and safeguarding coherent ecological networks at the landscape-scale, although the new Countryside Stewardship scheme could play an important role in the development of such an approach.

Coherent ecological networks will increase the chances of species being able to adapt to climate change by enabling them to move through the landscape as their 'climate space' shifts, and avoid being trapped in isolated pockets of remaining habitat.

Species move through the countryside in part by using habitat features that act as natural connections, such as rivers, canals and hedgerows. Species also move via stepping stones provided by habitat features. The restoration of coherent ecological networks that allow such movement at a landscape-scale is an adaptation priority for biodiversity conservation. By working at the landscape-scale, there is also scope to identify and protect potential 'refugia', areas where species are more likely to persist under a changing climate.

The Lawton Review recommended that large areas of the country should be recognised as Ecological Restoration Zones, where approaches aimed at restoring ecological networks could be developed. In response, the Natural Environment White Paper committed to the establishment of Nature Improvement Areas.⁸⁷ In 2012, twelve partnership projects were selected, with dedicated funding of £7.5 million over three years.⁸⁸ They aim to try out different approaches over a variety of landscapes, with different objectives and types of partnerships. The twelve NIAs collectively cover a little under 3% of England's land area.

⁸⁷ HM Government (2011) *The natural choice: securing the value of nature*, <https://www.gov.uk/government/publications/the-natural-choice-securing-the-value-of-nature>

⁸⁸ *Ibid.*

Although in existence for less than three years, the pilot NIAs have already had an impact in co-ordinating action to increase the extent of priority habitat. Across the twelve NIAs, priority habitats covering nearly 7,500 hectares have been created or restored and a further 3,000 hectares are planned to be created.⁸⁹

Recognition of climate change pressures is high amongst the NIA partnerships, and seven of the twelve NIA plans include specific adaptation objectives. Detailed assessments of the vulnerability of habitats and species to climate change impacts have been carried out for five NIAs, using a spatial mapping model developed by Natural England.⁹⁰ These vulnerability assessments have been used to target areas for habitat creation and restoration that will enhance the coherence of ecological networks.

It is too early to be able to assess objectively the impact of actions by NIA partnerships on species populations and distributions. Perhaps more importantly at this stage, the long-term future of the NIA initiative is unclear. Defra have not come forward with any plans to extend initial funding, which ended in March 2015, or to roll out the approach to other landscapes.

Conservation charities do much to promote and develop landscape-scale initiatives.

- The Woodland Trust works with other landowners to restore ancient woodland sites and plant new native woodlands to buffer and extend existing woodland patches.
- The RSPB's Futurescapes initiative is advocating landscape-scale approaches across 36 different areas in the UK.⁹¹
- The Wildlife Trusts' Living Landscapes initiative aims to identify and promote a realisable national ecological network. Many Wildlife Trusts have mapped the potential of existing habitats and the locations where habitats could most effectively be restored.⁹²

The new agri-environment scheme, Countryside Stewardship, will be targeted in a way that aims to help deliver coherent ecological networks at a landscape-scale.

Countryside Stewardship, the next national agri-environment scheme to be funded under Pillar II of the CAP, will be available from January 2016. As with the Environmental Stewardship scheme it replaces, there will be two tiers, with the higher tier similar to HLS in that it will be targeted and discretionary.

Natural England will be receiving applications from landholders to enter the higher tier scheme later in 2015. Five year agreements are planned. Targeting will be based, in part, on spatial mapping of 'climate refugia' areas and projected changes in climate space. Such an approach will encourage the take-up of agri-environment options that should help deliver more coherent ecological networks across the farmed countryside.

It will be important for monitoring to be in place from the outset to review the extent to which implementation of Countryside Stewardship is helping to deliver coherent ecological networks that account for current and projected changes in climate space.

⁸⁹ Collingwood Environmental Planning (2014) *Monitoring and Evaluation of Nature Improvement Areas: Year 2 (2013-14) Progress Report*. Defra Research Project WC1061

⁹⁰ Natural England (2013) *Assessing and enabling climate change adaptation in Nature Improvement Areas* (NECR119), <http://publications.naturalengland.org.uk/publication/5935762914672640>

⁹¹ <https://www.rspb.org.uk/whatwedo/futurescapes/sites.aspx>

⁹² <http://www.wildlifetrusts.org/living-landscape>

6.4 Conclusions on NAP objectives and actions

The table below summarises progress as far as can be established against the objectives listed within the NAP for the Natural Environment theme. In general, the objectives describe a number of processes and list actions by which the resilience of the natural environment should be improved.

Of the 86 actions in the Natural Environment chapter of the NAP:

- 13 (15%) are completed;
- 54 (63%) are on-track;
- 13 (15%) have been revised or delayed; and
- 1 (1%) has been dropped.

Updates were not provided to the ASC for 5 actions (6%). The majority (66%) of actions are time-bound with the remainder classed as 'on-going'.

Table 6.1: NAP objectives and a summary of progress for the natural environment theme

NAP objective	Commentary on progress
Objective 19: To build the resilience of wildlife, habitats and ecosystems (terrestrial, freshwater, marine and coastal) to climate change, so as to put our natural environment in the strongest possible position to meet the challenges and changes ahead.	<p>There are 48 actions under this objective, which make up more than half (55%) of all actions for the theme. The actions are categorised into terrestrial, freshwater, marine and coastal ecosystems and the historic environment. The majority (29 out of 48) of actions are on-track.</p> <p>Most actions refer to existing policy initiatives and programmes that are building resilience to climate and non-climate risks. These include meeting the Biodiversity 2020 commitments, taking forward the Restoring Sustainable Abstraction programme, and establishing Marine Conservation Zones. There are also a number of actions to raise awareness and address evidence gaps, including publication of an adaptation manual for land managers and conservation practitioners, and promoting vulnerability assessment and mapping tools.</p> <p>As highlighted in this chapter, whilst there are noteworthy advances being made to build the resilience of the natural environment to climate change, there are a number of trends that suggest the vulnerability may still be increasing, or is certainly not yet declining.</p> <p>This objective also includes actions being taken to improve the resilience of the historic environment, including the production of adaptation reports by English Heritage and by the Church of England. Both of these reports have been delayed and the consideration of adaptation to climate change appears to be at an early stage for the heritage sector.</p>

Table 6.1: NAP objectives and a summary of progress for the natural environment theme

NAP objective	Commentary on progress
<p>Objective 20: To take action to help wildlife, habitats and ecosystems accommodate and smoothly transition through inevitable change.</p>	<p>There are 11 actions for this objective. They include the preparation of climate change risk assessments by organisations, such as the English National Parks and the Ministry of Defence. There are also actions owned by non-government organisations to embed adaptation into their management of sites. Natural England is reviewing how its notification strategy for SSSIs accounts for climate change impacts, and is incorporating climate change into management plans for European designated sites and National Nature Reserves. Almost all actions (10 out of 11) for this objective are either complete or on-track.</p> <p>There is some evidence from the actions that more flexible approaches to conservation are being taken by the sector. However, the actions for this objective are somewhat ad-hoc and it is not possible to arrive at an overall assessment of the progress being made against this objective</p>
<p>Objective 21: To promote and gain widespread uptake in other sectors of the use of adaptation measures that benefit and/or do not adversely affect the natural environment.</p>	<p>There are 12 actions for this objective, with 10 of the 12 actions on-track, one complete, and no update received for the remaining action (for all public authorities to have regard to conserving biodiversity whilst exercising their functions). The actions mainly focus on promoting green infrastructure in urban areas, and on-going work to develop the concept of Payment for Ecosystem Services (PES). A specific action in relation to PES is the development and piloting of a Peatland Carbon Code, with the pilot phase due to end in July 2015. Due to the loose wording of this objective and lack of monitoring it is not possible to say to what extent it is being achieved.</p>
<p>Objective 22: To improve the evidence base, to enhance the knowledge and understanding of decision makers, land managers and others of the impacts of climate change on the natural environment and how best we can influence adaptation or accommodate change</p>	<p>There are 15 actions for this objective. Five of these have been completed, six are on-track, and four have been delayed or revised. A number of long-term monitoring and research programmes are referred to in the actions. These include:</p> <ul style="list-style-type: none"> • The UK Ocean Acidification research programme; • The Environmental Change Network; • Defra research into soil degradation; and • Environment Agency research into low-flows. <p>There are also actions associated with disseminating research, such as the Living With Environmental Change (LWEC) Climate Impact Report Cards.⁹³</p> <p>Overall, it is evident that there is a significant amount of effort being delivered to monitor long-term climate impacts and enhance knowledge and understanding by practitioners in the sector.</p>

93 See: <http://www.lwec.org.uk/resources/report-cards>



Chapter 7: Business

7.1 Climate change and businesses

7.2 Risks and opportunities to businesses from climate change

7.3 Progress being made

7.4 Conclusions on NAP objectives and actions



Key messages

Businesses are exposed to a range of climate hazards, both directly in terms of flooding and water scarcity, but also indirectly through impacts on their supply chains and changes to the natural capital they rely on. Financial services companies may also be affected if the value of their assets changes unexpectedly as a result of extreme weather events. Investment in resilience measures will reduce risks and create new market opportunities for adaptation technologies, goods and services.

Businesses increasingly have contingency plans in place in case of extreme weather events. However, there is little evidence of action being taken to reduce the physical risks from extreme weather, such as investing in property-level flood protection measures, particularly among small and medium sized enterprises. Some multi-national companies are beginning to manage climate change risks to overseas supply chains, which may provide them with a competitive advantage.

Overview of progress

Adaptation priority	Is there a plan?	Are actions taking place?	Is progress being made in managing vulnerability or realising opportunities?
1. Business impacts from extreme weather	Green	Green	Amber
2. Supply chain interruptions	Amber	Amber	Amber
3. Water demand by industry	Amber	Green	Green
4. Business opportunities from climate change	Green	Green	Amber

Notes: The criteria for Red, Amber, Green or Grey status for each of the three questions are as follows:

Is there a Plan? Green - where needed, plans or policies are in place that fully address the adaptation priority in the context of climate change. Amber - plans or policies are in place that partially address the adaptation priority. Red - no specific policies or plans are in place.

Are actions taking place? Green - all relevant NAP actions are complete or on-track, other relevant actions or commitments are being implemented. Amber - not all relevant NAP actions are on-track, partial delivery of other actions or commitments. Red - NAP actions mostly delayed or dropped, other relevant actions behind schedule.

Is progress being made in managing vulnerability? Green - trends in vulnerability are reducing or not increasing; high uptake of low-regret adaptation measures; long-term decisions are accounting for the future climate. Amber - some trends in vulnerability are increasing; scope to increase low-regret adaptation; decisions partially or inconsistently account for the future climate. Red - most trends in vulnerability increasing; minimal or zero uptake of low-regret adaptation; long-term decisions not taking the future climate into account. Grey - insufficient evidence to make a judgement.

See Chapter 1 for a full description of the approach.

Summary of progress

There are some positive signs of progress being made by businesses to prepare for climate change, supported by actions in the National Adaptation Programme (NAP).

- **The number of businesses preparing for extreme weather events is increasing.** The Environment Agency and others have published a series of guidance documents and tools to promote and facilitate adaptation by businesses, tailoring advice to different business needs. An increasing number of firms have business continuity plans, are signed up for flood warnings, or are accessing the tools and guidance provided.

- **Some large multi-national companies are assessing and actively managing the risks to their supply chains from a changing climate.** Around one-third of large multi-national companies based in the UK have identified one or more risks to their supply chains. Nearly all of these companies are actively managing this risk, for example, by investing in research, and diversifying their supplier and customer base. Many of these early adopters identify supply chain resilience as a possible competitive advantage.
- **Water use by industry is falling.** Water use by industry has fallen by around one-quarter since 2000. Food and drink manufacturing sites are also on track to deliver a voluntary commitment to reduce water use at their sites by one-fifth by 2020 relative to 2007 levels.
- **Businesses in England have considerable expertise in producing adaptation goods and services.** UK companies provide important adaptation goods and services such as flood protection measures, professional services including architecture and engineering, and finance and insurance services. This suggests they could take advantage of future growth in the market.

However, progress is far from universal and there is limited evidence of businesses taking steps to reduce the physical risks, particularly from flooding.

- **There remain a large proportion of businesses that are not taking measures to prepare for extreme weather events.** Half of all businesses do not have a business continuity plan. Only one-fifth of businesses located in areas with a high likelihood of flooding (1-in-30 or greater annual chance) have chosen to register for the Environment Agency's Flood Warnings Direct service. The Environment Agency has automatically registered the remaining businesses in flood risk areas for Extended Flood Warnings, although this provides only a limited service. The majority of companies reporting under the Carbon Disclosure Project have not identified any climate risks to their supply chains. This is despite two-thirds of these firms being in the same sector as other firms that have reported supply chain risks.
- **There is relatively little action being taken on the ground to reduce the physical risk from flooding.** The uptake of property-level flood protection measures, such as flood gates or air brick covers, remains low.
- **Recent growth in sales of adaptation goods and services has been slow.** Sales of adaptation goods and service by UK companies have grown at a slower rate than sales by overseas competitors in recent years. There are large uncertainties in the data, but this may suggest there are barriers limiting growth.

Recommendations for further progress

The Government's role in supporting business adaptation is primarily to encourage and enable businesses to make well informed decisions, for example by providing information. For this reason, the recommendations in this chapter focus mainly on improving the evidence base, providing information to businesses, and strengthening incentives.

- **RECOMMENDATION 31:** The Environment Agency should evaluate the impact of the adaptation tools and guidance it has published, including the Climate Ready support service, in time for the ASC's next progress report in 2017. The results of this should be used to identify to what extent businesses at most risk are using the tools and whether there is a need to amend them to better reflect user needs, particularly for SMEs.

- **RECOMMENDATION 32:** Defra should evaluate the 'Repair and Renew' grant scheme within a year of this report and develop new policies in time for the next NAP due in 2018, to encourage businesses in high risk areas to improve their resilience to flooding and fit property-level flood protection measures where appropriate.
- **RECOMMENDATION 33:** The Department for Business, Innovation and Skills should assess the case for regulatory and non-regulatory measures and take action to encourage all listed companies to report on their exposure to risks from climate change, and how those risks are being managed. This assessment should be completed in time to inform the next NAP due in 2018.
- **RECOMMENDATION 34:** The Bank of England should undertake research to better understand the potential systemic risks from climate change to the finance sector, building on the forthcoming report under the Adaptation Reporting Power by the Prudential Regulatory Authority. The research should be completed in time to inform the next NAP, due in 2018. The third round of ARP reporting should be extended to cover all areas of the finance sector.
- **RECOMMENDATION 35:** Defra should develop options in time for the next NAP, due in 2018, to encourage industry to improve water efficiency particularly in water stressed areas. This will help companies to make the transition to the likelihood of tighter restrictions and higher prices for water use during times of water scarcity, under abstraction reform.

Vision: "UK businesses are resilient to extreme weather and prepared for future risks and opportunities from climate change."

HM Government, 2013 National Adaptation Programme

7.1 Climate change and businesses

Recent events in England highlight the economic damage that can be caused by severe weather. The frequency and intensity of flooding, heatwaves, and droughts, is anticipated to increase with climate change. By investing in adaptation measures, businesses can increase their resilience to these risks both now and in the future, reducing expected financial losses. In addition, businesses better able to anticipate and cope with climate change and extreme weather than their competitors may be able to benefit commercially.

Businesses can also be disrupted by climate-related events that affect their suppliers, customers and the infrastructure assets they rely on. While these risks are not within their full control, there are a number of steps businesses can take to reduce the impacts associated with disruptions to their supply and distribution networks. The resilience of infrastructure assets is considered in more detail in Chapter 3.

As well as presenting risks, climate change could provide opportunities for businesses. Businesses will have an important role to play in the provision of goods, services and technologies to increase the resilience of the UK to the risks from climate change.

7.2 Risks and opportunities to businesses from climate change

Businesses in England are exposed, directly or indirectly, to a number of climate-related risks, including flooding, potential water shortages, and extreme heat.

- Some businesses choose to locate in areas at risk of flooding from rivers and the sea for commercial reasons. Proximity to water may be important for abstraction, discharges or transport. An estimated 594,000 non-residential properties are currently at risk of river or coastal flooding, of which 91,000 are at a 1-in-30 or greater chance (high likelihood) of flooding in any given year. Even if all cost-effective flood defence schemes are built over the coming decades, and all existing flood assets are optimally maintained and renewed, the number of non-residential properties in areas at a high likelihood of flooding is expected to rise to 94,000 by the 2060s. Around 598,000 non-residential properties are also at risk of surface water flooding caused by a shortfall in local drainage capacity. Increases in the intensity and frequency of heavy rainfall events will lead to a rise in the risk of surface water flooding.¹
- The mining and quarrying, food and drink, chemicals manufacturing, and paper manufacturing sectors, are among the largest industrial users of water. Some sites are located in areas where there are already pressures on water resources. Population growth and climate change is expected to place additional pressure on these resources, increasing the risk of water supply restrictions. The tendency for companies within a sector to co-locate, potentially in water scarce areas, could exacerbate the impacts on businesses and supply networks.
- When temperatures exceed certain thresholds in the workplace the productivity of workers has been observed to fall.² The precise relationship between outdoor temperatures, indoor temperatures and the response of workers is complex and will differ between occupations. Nevertheless, past events suggest extreme outdoor temperatures can have significant effects on production. The 2003 European heatwave is estimated to have resulted in a loss in manufacturing output in the UK of £400 - £500 million (2003 prices).³ By the 2040s, half of all summers in Europe are expected to be as hot, or hotter, than in 2003.⁴
- Many businesses are also exposed to climate impacts through their supply chains, both from UK suppliers and those overseas. Businesses in the food and drink, retail and some manufacturing sectors are likely to be at greatest risk from impacts abroad.⁵ Disruptions to suppliers can affect production in England and increase the costs of sourcing inputs for production. Disruptions to customers downstream in supply chains also present risks, particularly for the finance sector. Quantifying the size of this risk is difficult as supply networks are complex, but recent events, such as the floods in Thailand in 2011, provide insights into the potential impacts.

1 Environment Agency (2014) *Flood and coastal erosion risk management. Long term investment scenarios (LTIS) 2014*, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/381939/FCRM_Long_term_investment_scenarios.pdf

2 HM Government (2012) *CCRA for the business, industry and services sector*, <http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=15747#RelatedDocuments>

3 Martin et al. (2011) for the ASC *The sensitivity of UK manufacturing firms to extreme weather events*, http://archive.theccc.org.uk/aws2/ASC%202nd%20Report/LSE_final.pdf

4 Stott et al. (2004) in Met Office (2014) *To hot, too cold, too wet, too dry: Drivers and impacts of seasonal weather in the UK*, http://www.metoffice.gov.uk/media/pdf/4/8/Drivers_and_impacts_of_seasonal_weather_in_the_UK.pdf

5 University of Leeds (2014) for the ASC *Estimating global value chain impacts associated with UK consumption patterns*, <http://www.theccc.org.uk/wp-content/uploads/2014/07/8-2014-03-19-Estimating-global-value-chain-impacts-associated-with-UK-consumption-patterns.pdf>

- In addition to the risks, climate change presents opportunities to businesses from the sales of adaptation goods and services. Sales of adaptation goods and services by UK companies were estimated to be £2.1 - £6.1 billion in 2011/12, depending on how sales are categorised. This is equivalent to around 0.1% of total sales in the UK.⁶ The 2012 Climate Change Risk Assessment also identified possible opportunities for the tourism sector, as increases in temperatures may make England a more attractive tourist destination.⁷ The UK might also gain a competitive advantage in comparison to other countries if they are more severely affected by climate change impacts.

In response to these risks, the Government's National Adaptation Programme (NAP) sets five objectives for the business sector.

The objectives were identified following consultation across a wide range of stakeholders with expertise in climate change and business, including industry representatives, statutory bodies, and environmental charities.

- **Objective 23.** To raise awareness and understanding amongst businesses about climate change risks.
- **Objective 24.** To increase the extent to which businesses are actively considering climate change impacts in their risk management and resilience planning and decision-making process and taking appropriate adaptive action.
- **Objective 25.** To raise awareness and understanding amongst businesses about domestic and international adaptation opportunities.
- **Objective 26.** To help businesses better understand and manage climate risks to their supply chains.
- **Objective 27.** To undertake research to increase the understanding of climate change impacts on growth and the economy, working with investors, insurers and other partners.

The NAP objectives focus primarily on increasing business awareness to current and future climate risks, to enable them to take well-informed decisions. We have reviewed progress by the actions in the NAP against each objective in Section 7.4 below.

As noted in Chapter 1, the NAP objectives tend to describe processes rather than outcomes and do not always 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 NAP themes. The progress being made in respect of each of these adaptation priorities is reviewed in Section 7.3.

⁶ Based on figures reported in: K-Matrix (2013) for BIS *Adaptation and resilience (climate change). Report for 2011/12*; and K-Matrix (forthcoming) for GLA. The higher estimate uses a broader definition of adaptation goods and services, published in the report by K-Matrix for GLA.

⁷ HM Government (2012) *CCRA evidence report*, <http://randd.defra.gov.uk/Default.aspx?Module=More&Location=None&ProjectID=15747>

Figure 7.1 summarises the climate hazards, contextual factors and adaptation priorities that the ASC has identified for the business theme and the relevant actions in the NAP for each of these priorities.

Figure 7.1: Climate hazards, contextual factors and adaptation priorities for the business theme			
Climate hazards	Contextual factors	Adaptation priorities	Relevant NAP actions
Sea level rise and flooding Heavier rainfall Reduced water levels/flows Drought Higher average and extreme temperatures	Population growth	Business impacts from extreme weather	<ul style="list-style-type: none"> Promote tools and guidance including the Business Resilience Health Check and Business Continuity for Dummies Pilot resilience training programme to support SMEs Review workplace temperature guidance Incorporate adaptation into existing professional standards
	Consumer preferences		
	Economic growth	Supply chain interruptions	<ul style="list-style-type: none"> Publish guidance for businesses on managing supply chain risks and pilot guidance with companies in the food and drink retail sector
	Technological change	Water demand by industry	<ul style="list-style-type: none"> Continue to deliver the Federation House Commitment target to contribute to the reduction in water use in the food and drink industry by 20% in 2020 Continue to reduce water demand through the WRAP Rippleffect water efficiency advisory service
	Increasing global trade		
	Industry composition	Business opportunities from climate change	<ul style="list-style-type: none"> Promote and facilitate international commercial opportunities for UK companies with adaptation expertise Gather evidence on the size of the market
Notes: The actions listed reflect the ASC's summary of the main actions in the NAP.			

7.3 Progress being made

This section evaluates the extent to which the actions and policies in the NAP and elsewhere are addressing the identified climate risks, following the method described in Chapter 1. Further details and the underlying evidence supporting the analysis is provided in an annex to this report available on the CCC's website.⁸

7.3.1. Business impacts from extreme weather

Is there a plan?		The Government's six-year investment plan aims to better protect businesses from flood risk. Defra's Partnership Funding policy encourages businesses to invest in community-scale flood defences that will benefit their business. The Environment Agency's Climate Ready service provides advice to businesses to encourage and promote adaptation.
Are actions taking place?		The Environment Agency and others have published a number of guidance documents and tools for businesses to use. Workplace temperature guidance has been simplified. Management standards are being revised to better reflect the need to consider adaptation.
Is progress being made in managing vulnerability?		Businesses are increasingly taking action to prepare for flood events. The proportion of businesses with continuity plans and signed up for flood warnings is rising. However, there is minimal evidence of action being taken to directly improve resilience to extreme weather, particularly among SMEs. This is partly due to lack of available data, but where data are available action still appears low.

⁸ See: <http://www.theccc.org.uk/publications/>

Flooding represents the clearest weather-related risk to business operations with climate change. Activity to prevent flood damage to businesses is currently being driven by the Government, as part of the general approach to alleviating flood risk to people and property.

Flooding imposes significant costs on businesses, both in terms of damage to assets and in disruption to business activity. For example, the floods in 2007 were estimated to cost businesses in England £740 million in clean-up costs and lost business. Between 7,000 and 8,000 commercial buildings are estimated to have been affected.⁹ On average, it took affected businesses 26 weeks to return to full capacity, with some businesses closing down permanently.¹⁰ More recently, the floods in the winter of 2013/14 were estimated to cost small businesses £831 million.¹¹

Around 594,000 non-residential properties and 3.2 million employees are located in areas susceptible to flooding from rivers or the sea.^{12,13} Approximately 91,000 of these properties are located in areas at a high likelihood of flooding, with a 1-in-30 or greater chance of flooding in a given year. An estimated 598,000 non-residential properties are at risk of surface water flooding, of which 73,000 are in areas at a high likelihood of flooding.

Activity to prevent flood damage to businesses is primarily driven by the Government through the Flood and Coastal Erosion Risk Management Strategy for England. As part of this strategy, a total of £2.5 billion has been allocated to managing flood and coastal erosion risk over the period April 2011 to March 2015.¹⁴ Business benefits are quantified as part of the appraisal of flood defence options, and taken in to account in the allocation of national funding to projects. Where national funding is insufficient to meet the full costs of a scheme, businesses are encouraged to contribute towards the shortfall as part of the Flood & Coastal Resilience Partnership Funding policy introduced in May 2011. Over the last three years the national programme of flood and coastal defence projects overseen by the Environment Agency improved flood protection for 16,000 commercial properties in England.¹⁵

Local Enterprise Partnerships (LEPs) can leverage additional funding to support flood risk management measures in their area. A review of proposals made by LEPs covering areas at the greatest risk of flooding in England found eight out of ten had considered the risks of flooding in their Strategic Economic Plan (SEPs). The SEPs set out the LEP's strategy for local growth, including the use of resources such as the Local Growth Fund and European Structural Investment Funds (ESIF). The review also found that all but one LEP had identified flooding as a risk to be addressed in their specific plans for the allocation of funding from ESIF and one-third identified flood risk in their Local Growth Fund planned allocations. One of the eleven objectives set by the Government in its strategy for ESIF was to promote climate change adaptation, with a focus on flood and coastal erosion risk management. In total, around £140 million investment from ESIF and the Local Growth Fund has been allocated to climate change adaptation, primarily to address flood risk.¹⁶

9 Environment Agency (2010) *The costs of the summer 2007 floods in England*, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/291190/scho1109brja-e-e.pdf

10 Environment Agency (2013) *How to prepare a climate change action plan – Food and drink sector guidance*, <https://www.fdf.org.uk/publicgeneral/Climate-Ready-FDF-Adaptation-Guide.pdf>

11 Federation of Small Businesses (2014) *Floods cost small firms £831 million*, <http://www.fsb.org.uk/news.aspx?rec=8544>

12 Environment Agency (2014).

13 HR Wallingford (2015) for the ASC *Development in areas of flood risk and coastal erosion*.

14 Consisting of Flood & Coastal Erosion Risk Management Grant-in-Aid to the Environment Agency (£2.22 billion), emergency funds released after the 2013/14 winter storms (£178 million), and external contributions under the Partnership Funding policy (£136 million).

15 Defra (2014) *Reducing the risks of flooding and coastal erosion. An investment plan*, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/389789/fcerm-investment-plan-201412.pdf

16 JBA (2015) for the ASC *Research to survey local authority action on climate change adaptation*.

Even if all worthwhile community-scale flood defences are built in the coming decades there will be more commercial properties in areas of high flood risk than there are today. Businesses need to take proportionate action to protect individual properties and assets in order to manage this residual risk.

There are expected to be 3,000 more non-residential properties in areas at a 1-in-30 or greater annual chance of flooding in the 2060s than there are now, even if all worthwhile community flood defences are built and all existing flood defence assets are optimally maintained and renewed.¹⁷ This highlights the importance of businesses taking steps at a company or property-level to manage the risk of flooding both now and in the future. The level of flood protection the Government will be able to justify to the taxpayer may fall short of business needs in some areas. The incentive for Government to prevent flood damage to individual businesses is also limited, as economic activity tends to be displaced or postponed during a flood rather than lost altogether.

Businesses are increasingly putting in place plans to respond and recover from flood events, supported by advice provided through actions in the NAP. However, there is relatively little evidence of actions to reduce the physical risk from flooding, such as investing in property-level flood protection measures, particularly amongst SMEs.

The NAP refers to a number of actions to encourage and enable businesses to manage the risk of flooding. Tools, guidance and training courses have been 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 updates on the NAP actions provided by these organisations suggest the tools and guidance have been used by a number of businesses. For example, the Business Resilience Health Check, developed by the Environment Agency with Business in the Community and Climate UK, has been accessed by 2,000 organisations to date. The tool helps businesses identify whether they are at risk of flooding and brings together the Agency's advice on preparing for flooding.

RECOMMENDATION 31: The Environment Agency should evaluate the impact of the adaptation tools and guidance it has published, including the Climate Ready support service, in time for the ASC's next progress report in 2017. The results of this should be used to identify to what extent businesses at most risk are using the tools and whether there is a need to amend them to better reflect user needs, particularly for SMEs.

There are a number of other actions businesses can take to increase their resilience to flooding.

- **Flood warnings** provide information to businesses ahead of a potential flood event. These allow decisions to be taken on moving stock, employees and other assets to reduce damages and disruption. The number of businesses actively registered for the Environment Agency's free Flood Warnings Direct (FWD) scheme has increased from 24,600 in 2007 to 63,800 in 2013. However, less than one-fifth of businesses in areas at high risk of flooding have actively opted-in to receive the full FWD service, suggesting a low level of awareness of flood risk of many businesses in flood risk areas.¹⁸ In response to the Pitt Review the Environment Agency launched the Extended Direct Warnings (EDW) service, which automatically registers all fixed line telephone numbers identified as being within flood risk areas. The service provided through the EDW is less comprehensive than the FWD, but should ensure most businesses receive at least a basic warning ahead of potential flood events.

¹⁷ Environment Agency (2014).

¹⁸ ASC (2014) *Managing climate risks to well-being and the economy*, <http://www.theccc.org.uk/publication/managing-climate-risks-to-well-being-and-the-economy-asc-progress-report-2014/>

- **Business continuity plans** support businesses to respond to and recover from a flood event. The proportion of private sector organisations reporting that they have a business continuity plan in place rose from 42% in 2008 to 58% in 2013. 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.¹⁹ 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. A recent survey by the Federation of Small Businesses found 59% of SMEs did not have a continuity plan in place.²⁰
- **Property-level protection (PLP)** measures, such as flood gates and air brick covers, can prevent flood water entering buildings. Damages can be limited by the fabric of buildings being made more resilient to flood water, for example by placing electric sockets above potential water levels. Following the floods in the winter of 2013/14 the Government introduced a 'Repair and Renew' grant, providing financial support of up to £5,000 for the businesses and households that had been affected. At the same time, the Government announced it would provide business rate relief for up to three months for businesses that were flooded. Defra has been unable to provide figures on the number of businesses supported by the scheme, but between 2012/13 and 2014/15 1,400 households and businesses received funding for property-level flood protection measures. Feedback from flood protection manufacturers suggests overall uptake of property-level protection measures by businesses is relatively low. Better information is needed at a national scale on the uptake of these measures and the barriers to their more widespread adoption. Lessons from the Repair and Renew grant scheme offer an opportunity to develop this evidence base.
- **Permeable paving** used in hard surfacing around business premises can improve drainage and reduce the risk of surface water flooding. While the use of permeable paving within the commercial sector has increased in recent years, it remains a relatively small part of total paving activity. Impermeable paving remains the dominant paving type in commercial projects, with 86% of block paving supplied for commercial sector projects in 2013 being impermeable.²¹

RECOMMENDATION 32: Defra should evaluate the 'Repair and Renew' grant scheme within a year and develop new policies in time for the next NAP due in 2018, to encourage businesses in high risk areas to improve their resilience to flooding and fit property-level flood protection measures where appropriate.

Heat stress during periods of high summer temperatures may become a significant issue for labour productivity. More research is needed to understand the sectors that are exposed and whether additional policy is needed. Changes to management standards, such as those governed by the International Organisation for Standards (ISO), offer an opportunity to ensure adaptation to heat stress and climate risks more generally are integrated into existing business practices.

The risk of overheating in a work environment is not just a function of temperature, but also of humidity, air speed, clothing and the activity of workers. Workers engaged in heavy outdoor manual labour, particularly in the agriculture, construction and heavy industry sectors, are likely to be at the greatest risk of heat stress.

¹⁹ Chartered Management Institute (2013) *Weathering the storm. The 2013 business continuity management survey*, <http://www.bsigroup.com/Documents/iso-22301/resources/Weathering-the-storm-CMI-UK-EN.pdf>

²⁰ Federation of Small Businesses (2014) *FSB warning as more than half of small firms without flood plan*, <http://www.fsb.org.uk/news.aspx?rec=8855>

²¹ Jenco Consultancy Ltd and Climate Resilience Ltd (2014) for the ASC *Research to ascertain the proportion of block paving sales in England that are permeable*, http://www.theccc.org.uk/wp-content/uploads/2014/07/7-ASC-paving-survey-report_for-publication.pdf




Employees working in offices built in the 1960s and 1970s could also be at risk. These types of building typically have poor ventilation systems and are often high-rise properties with single glazed windows that maximise solar gain.²²

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 businesses in meeting this requirement, the Health and Safety Executive has published workplace temperature guidance. This has been simplified as part of the NAP.

Although there is now an understanding of the types of industries at risk, only a few studies have considered the impacts of heat stress on productivity in England. There is a need for further research in this area to better understand the types of employment at greatest risk, and the effectiveness of planned or autonomous adaptation to manage these risks, including the role of workplace temperature guidance.

Changes to management standards could be made to encourage more firms to consider the potential benefits from adapting to heat stress and other climate risks. Management standards provide guidance and models for businesses to follow based on international and expert consensus. There are a number of initiatives currently underway. For example, the ISO will publish an updated version of ISO 14001 later in 2015, requiring companies to consider the impact of the environment on their operations, in addition to the impact they have on the environment. Companies will have three years to demonstrate they meet the new requirements. 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.²³ The ISO is also due to publish a report later in 2015 that will consider ways in which adaptation can be better integrated into standards across the board.

7.3.2. Supply chain interruptions

Is there a plan?		Whilst there is no specific Government plan or strategy directly addressing this risk, there is guidance and support available to those companies wishing to assess and manage their vulnerability to disruptions. The Government does not currently plan to assess nor manage systemic risks to supply chains and the financial sector from climate change.
Are actions taking place?		The Environment Agency has published guidance on managing risks from climate change to supply chains. This is being piloted with Asda and M&S, although there have been some delays in completing the pilot. As part of the Industrial Strategy, the Department for Business, Innovation and Skills (BIS) has also considered the development of resilient supply chains.
Is progress being made in managing vulnerability?		Measuring progress is difficult due to the complex nature of supply networks and lack of publicly available information. Self reported data through the Carbon Disclosure Project and Businesses Continuity Institute suggest some large multi-national companies are managing risks of disruptions to suppliers, but this is far from universal. Current actions focus on identifying alternative suppliers, but companies also need to work with their existing suppliers and supply chains to promote long-term resilience.

²² UKCIP (2005) *Beating the heat: Keeping UK buildings cool in a changing climate*, http://www.ukcip.org.uk/wordpress/wp-content/PDFs/Beating_heat.pdf

²³ ISO (2015) *ISO survey 2013*, <http://www.iso.org/iso/iso-survey>

Through their international supply chains, businesses in the UK 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. Changes in average temperature and water availability also present risks to supply chains in the long-term. Disruptions to supply chains have reputational and financial consequences for companies, and can be difficult to recover from.

Businesses in the UK operate as part of the global economy and as such are heavily reliant on goods and services sourced from and sold to overseas markets. As a proportion of GDP, UK international trade (imports plus exports) increased from 52% in 2003 to 62% in 2013.²⁴ This demonstrates the increasing reliance of UK businesses on overseas markets as part of their supply chains and distribution networks.

Flooding, storms and drought are common causes of supply chain disruption. A recent survey found adverse weather was the third most frequent cause of supply chain disruptions for UK companies, with around 75% of respondents reporting to have been affected at some point over the past 12 months.²⁵ In the longer-term, changes in water availability both in the UK and globally could pose more substantial risks to businesses. Around 70% of the total water used in production and consumption in the UK is imported from other countries in the form of water embedded in goods.²⁶

Disruptions to supply chains can have significant negative consequences for businesses. Studies have found that share prices can fall by between 7% and 30% on average following failures in the supply chain, relative to benchmark companies.²⁷

Previous analysis by the ASC identified that the food and drink, electronic equipment, clothing and some other manufacturing sectors are the most vulnerable to disruption with climate change.²⁸ This analysis was based on combining trade and production data with country-level vulnerability indices. The findings highlighted that the greatest risks appear to be in the earlier stages of supply chains, such as the sourcing of raw materials. These tiers of the supply chain are less likely to be understood and actively managed by UK businesses.

Some large multi-national companies say 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 reporting no supply chain risks 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.

In responses to information requests from the Carbon Disclosure Project (CDP), one-third of businesses identified one or more risks to their supply chains from climate change (Figure 7.2). Roughly half of the risks reported were to suppliers upstream in supply chains and the remaining half were risks to clients downstream in supply chains.

The most common approaches being taken to manage these risks are monitoring of climate trends and impacts, maintaining a diverse supplier and customer base, and undertaking risk assessments and research to better understand the potential size of the risks.²⁹ In many cases, risks were identified but insufficient evidence was provided to determine how these were being managed.

24 Department for Business, Innovation & Skills (2015) *Openness to trade: Exports plus imports as a share of GDP, ranked against major competitors*, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/401199/openness-to-trade-exports-plus-imports-as-a-share-of-gdp-ranked-against-major-competitors.pdf

25 ASC analysis of UK private sector responses to Business Continuity Institute and Zurich (2013) *Supply Chain Resilience 2013*, https://www.zurich.com/_/media/dbe/corporate/docs/whitepapers/supply-chain-resilience-2013.pdf?la=en

26 Chapagain, A.K. and Hoekstra, A.Y. (2008) The global component of freshwater demand and supply: An assessment of virtual water flows between nations as a result of trade in agricultural and industrial products. *Water International*. 33, 19-32.

27 Based on figures reported in: PwC (2008) *From vulnerable to valuable: how integrity can transform a supply chain*, <http://www.pwc.com/us/en/supply-chain-management/publications/supply-chain-report-download.jhtml>; Zurich Insurance (2013) *Strategic risk: Do not forget your supply chain*, <http://knowledge.zurich.com/supply-chain/strategic-risk-do-not-forget-your-supply-chain/>; and World Economic Forum (2013) *Building resilience in supply chains*, <http://www.weforum.org/reports/building-resilience-supply-chains>.

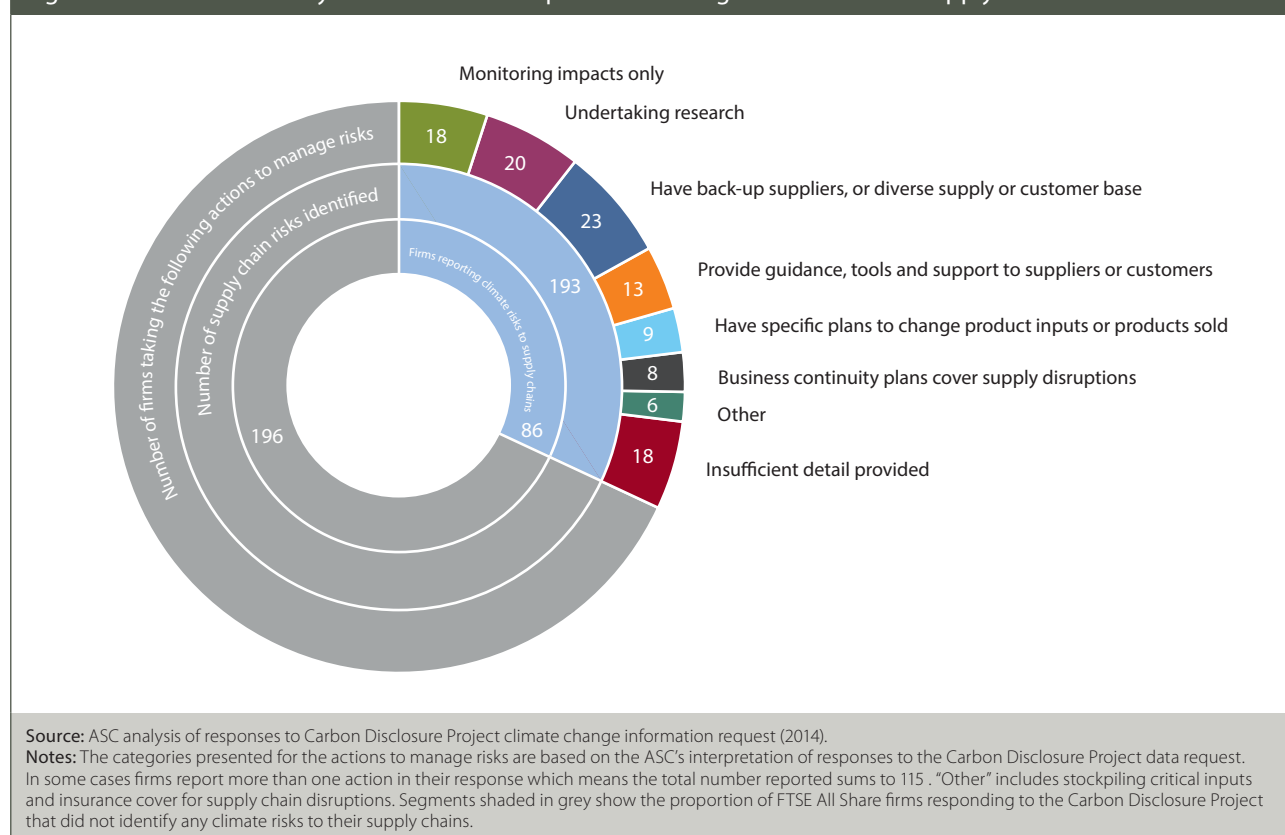
28 ASC (2014).

29 The number of businesses reporting to integrate supply chain disruptions into business continuity plans in responses to CDP is low in comparison to other sources. For example, a survey by the Business Continuity Institute found more than three-quarters of firms had business continuity plans to deal with supply disruptions. The low number reported in the CDP responses may be the result of responses to the question being free text, and businesses may consider this as standard practice.

Some companies are working in partnership with their suppliers and local communities to improve their resilience to climate risks. For example, Nestle is providing training to cocoa farmers on soil preparation, water conservation, efficient use of fertiliser, and techniques for more efficient land use, to improve the resilience of its cocoa supplies. Thomas Cook has developed a tool, Travelife, to help accommodation providers mitigate and adapt to climate change. RSA insurance is providing advice to customers on what to do before, during, and after, extreme weather events. This is helping to reduce claims and help customers. These actions provide reputational and financial benefits, and can help to maintain the long-term sustainability of supply chains. The alternative, of relying on being able to find an alternative supplier at short notice, carries risk.

Around 70% of firms responding to CDP did not identify any risks to their supply chains from climate change. Two-thirds of these firms are in the same sub-industries as other companies that reported at least one risk to their supply chains. These firms are likely to face similar risks to their competitors, and a lack of awareness and action could put them at a competitive disadvantage.

Figure 7.2: Actions taken by FTSE All Share companies to manage climate risks to supply chains



There are regulatory and non-regulatory measures that could be implemented to increase the number of companies disclosing information on climate risks. The EU non-financial reporting directive requires businesses to disclose information on policies, risks and outcomes with regards to environmental matters.³⁰ The directive focusses on the impact of businesses on the environment, but there is scope for firms to provide additional reporting. There are also existing initiatives that encourage firms to disclose the risks they face from climate change, and the policies in place to address those risks, such as the work of the CDP and the Climate Disclosure Standards Board.³¹

³⁰ European Parliament and the Council of the European Union (2014) *Directive 2014/95/EU*, <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014L0095&from=EN>

³¹ The Climate Disclosure Standards Board is a consortium of global business and environmental NGOs. In 2010 it introduced the Climate Change Reporting Framework to help companies disclose information about their climate change related risks and opportunities, and their implications for shareholder value in their financial reports.

RECOMMENDATION 33: The Department for Business, Innovation and Skills should assess the case for regulatory and non-regulatory measures and take action to encourage all listed companies to report on their exposure to risks from climate change, and how those risks are being managed. This assessment should be completed in time to inform the next NAP due in 2018.

The Environment Agency has published guidance to help companies identify and manage climate change risks to their supply chains. This is currently being piloted with companies in the food and drink retail sector. The Government is also providing funding to businesses to re-shore outsourced activities to the UK. Current uptake is low, but this activity could help to increase the resilience of these supply chains if re-shored activities are located in areas at low risk in the UK.³²

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. Businesses that are likely to be at higher risk include those that rely on suppliers clustered in one location, use 'just-in-time' production methods, source climatically-sensitive materials such as agricultural products, and stockpile in vulnerable locations such as floodplains. The guidance also sets out a number of steps smaller suppliers can take to increase their resilience to supply chain disruptions.

The Environment Agency is piloting the guidance with Marks & Spencer, including with forty of their suppliers. A pilot with Asda has been delayed due to changes in company staff. The focus to date has been on the food and drink retailing sector, although the Environment Agency is working with BIS and Defra to identify other sectors to target in the future.

The Government has also introduced the Advanced Manufacturing Supply Chain Initiative as part of its re-shoring agenda. The initiative offers funding to advanced manufacturing supply chains to encourage location within the UK. If situated in areas at low levels of future climate risks in the UK, this could increase the resilience of manufacturing supply chains. To date, the Reshore UK initiative has supported 22 companies to re-shore their activities to the UK, supporting 1,129 jobs. Other factors, such as changes in labour market costs, quality control, and the proximity to customers, are likely to be more important factors determining companies' decisions to re-shore.

The risks to the financial sector from climate change are currently not well understood. This is an area where further research is needed. The Prudential Regulatory Authority is to report under the Adaptation Reporting Power later in 2015. This will help develop understanding and determine future priorities.

In comparison to the insurance industry, there is less literature that considers the risks to financial institutions from climate change. Comparing the insurance and banking industry, the Foresight report on the international dimensions of climate change concluded that the supply of capital by banks was more vulnerable to climate change than the insurance industry.³³ This is because banks are more exposed to vulnerable markets, are locked in for longer periods of time, and may have less risk management expertise on the topic of climate change. Reports by KPMG and in the Climate Change Risk Assessment also identified the finance sector as at a high level of risk from climate change.^{34, 35}

Given the interconnectedness of the financial sector, any systemic risks associated with climate change could present a significant issue in the longer-term. This is an area that is seeing increased attention and further research is needed.

³² Re-shoring is the act of bringing outsourced personnel, services or production back to the UK from overseas.

³³ Government Office for Science (2010) *The impact of climate change overseas on the UK financial services sector*, <http://webarchive.nationalarchives.gov.uk/20140108140803/http://www.bis.gov.uk/assets/foresight/docs/international-dimensions/11-1024-impact-climate-change-overseas-on-uk-financial-services.pdf>

³⁴ HM Government (2012).




³⁵ KPMG (2008) *Climate changes your business*, https://www.kpmg.com/EU/en/Documents/Climate_Changes_Your_Business.pdf

Many financial services companies have not assessed the risks from climate change to their investments. A survey commissioned by the Global Investor Coalition on Climate Change found only one-half of asset managers that responded to the survey had conducted a climate risk assessment of their portfolios.³⁶ Similarly, a survey of 34 pension funds by the Asset Owners Disclosure Project found limited evidence of action being taken to assess and manage risks from climate change. In that survey, 24 of the pension funds were awarded the lowest two markings for disclosure, suggesting they had provided no or only some information on how they were managing climate risks.³⁷ This may be a result of companies not disclosing this information if it is viewed as commercially sensitive.

The Prudential Regulatory Authority is due to submit its Adaptation Reporting Power (ARP) report to Defra later this year. The report will focus mainly on the insurance sector. Expanding the scope of future ARP reports to include other areas of the finance sector would help to improve the evidence on actions being taken by financial institutions and where further guidance may be needed.

RECOMMENDATION 34: The Bank of England should undertake research to better understand the potential systemic risks from climate change to the finance sector, building on the forthcoming report under the Adaptation Reporting Power by the Prudential Regulatory Authority. The research should be completed in time to inform the next NAP, due in 2018. The third round of ARP reporting should be extended to cover all areas of the finance sector.

7.3.3. Water demand by industry

Is there a plan?		Many firms are regulated through the Industrial Emissions Directive. This encourages the uptake of Best Available Technologies including for water efficiency. Industry abstraction is subject to the abstraction licence regime, which is due for reform early in the 2020s. The food and drink sector has a plan in place to reduce water use by 20% by 2020, relative to 2007 levels. Other sectors do not have such targets.
Are actions taking place?		Food and drink manufacturing sites are on track to meet their voluntary contribution to the food and drink sector water use target. The Rippleffect advisory service, administered by WRAP, has supported 1,600 businesses since April 2013. Water savings achieved through the programme remain modest relative to total water use.
Is progress being made in managing vulnerability?		Industry abstraction and use of public water supply has fallen by around one-quarter since 2000. Recent declines are likely to be due to both the relative decline in production of large water using industries and improvements in water intensity.

³⁶ ClientEarth (2015) *Written evidence to the Environmental Audit Committee climate change adaptation inquiry*, <http://data.parliament.uk/writtenevidence/committeeevidence.svc/evidencedocument/environmental-audit-committee/climate-change-adaptation/written/12034.html>

³⁷ *Ibid.*

Water is used for a wide range of purposes by businesses and industry, and is an important input in production. Some businesses that use large volumes of water are already located in areas that are water stressed. To maintain a balance between supply and demand, and reduce the likely impacts on their operations from reductions in water availability, businesses need to manage water efficiently.

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.

Some businesses and industries abstract water directly from freshwater sources, such as rivers, streams and aquifers. In 2012, industry abstracted 983 billion litres of water from freshwater sources, equal to one-tenth of all water abstraction in England.³⁸ The mining and quarrying, and the food and drink, paper and pulp, and chemical manufacturing sectors, are among the largest industrial users of water. Together these sectors account for more than three-quarters of freshwater abstraction by industry.³⁹

Businesses source a similar volume of water from the public water supply. In 2012, 1,014 billion litres was consumed by non-residential customers, equivalent to around one-quarter of the total public water supply.⁴⁰ The use of public water supplies is spread more widely amongst a larger range of sectors, including wholesale and retail, and leisure industries. Around 90% of non-residential customers are metered and pay a charge that reflects the total amount of water they use.⁴¹

Previous analysis for the ASC has shown that significant proportions of the paper manufacturing, chemical manufacturing and mining and quarrying industries are located in areas where demand for water already exceeds supply during an average summer (around one-half, one-third, and one-tenth, respectively).⁴² To maintain a balance between supply and demand, and reduce the likely impacts on their operations from reductions in water availability in the future, businesses will need to use water more efficiently. However, in some cases improving efficiency will be insufficient to manage the risks. For example, mining and quarrying sites currently abstracting around one-tenth of the water used by the sector are located in areas where there is expected to be insufficient water for the environment in an average summer in the 2050s, even before water abstraction demands are considered. This poses a threat to the long-run viability of such operations.⁴³

38 Environment Agency (Online) *Water abstraction tables*, <https://www.gov.uk/government/statistical-data-sets/env15-water-abstraction-tables>

39 WRc (2011) for WRAP *Freshwater availability and use in the United Kingdom*, <http://www.wrap.org.uk/content/freshwater-availability-and-use-uk-0>. This is based on the proportion of water abstracted by each sector in 2006 and excludes water abstracted for agriculture and electricity, gas, waste, water and sewerage. Water demand by these sectors is covered in Chapter 3: Infrastructure and Chapter 5: Agriculture and Forestry of this report.

40 Environment Agency (unpublished).

41 Environment Agency (unpublished).

42 WRc (2014) for the ASC *Research to produce indicators to assess current and future risk to the chemicals, paper, mining and quarrying industries from reduced water availability, and potential uptake of water management measures in these industries*, <http://www.theccc.org.uk/wp-content/uploads/2014/07/9-UC10071-03-Research-to-produce-indicators-to-assess-the-risk-of-water-scarcity-from-climate-change-to-water-intensive-industries.pdf>. The fractions refer to the proportion of water abstraction by each industry in areas where demand exceeds supply during an average summer.

43 ASC (2014).

Abstraction by industry is governed by the abstraction licence regime, which is due for reform in the 2020s. Regulations and information schemes are also in place to encourage efficient use of water by industry.

Businesses that abstract water directly from the environment require an abstraction licence, which sets a limit on the water they can abstract. The existing licencing system has been in place since the 1960s and has largely allowed industries to continue abstraction even when water levels are low. The price paid for abstraction is often unrelated to the amount of water used, meaning there is a lack of a price signal to encourage efficient water use. The Government has set out its plan to reform the system in the 2020s, to encourage more sustainable use of water by industry and others at times when it is scarce.

Where abstraction levels are already unsustainable, the Environment Agency is investigating the causes and implementing measures through the Restoring Sustainable Abstraction programme. Measures being taken include reducing licence volumes and introducing Hands-Off-Flows, which limit or prevent abstraction when water levels fall below critical environmental thresholds. Only 5% of the licences identified for review are held by industry, whereas licences held for agriculture and public water supply account for 84% of licences being reviewed under the programme. This reflects the lower number of licences held by industry and lower concentrations of industry abstractions in catchments where pressures on water resources are greatest.

There are other regulations and schemes in place to encourage efficient use of water by industry.

- Many industrial sites have requirements placed on their resource efficiency through the Environmental Permitting Regulations, which implements the provisions in the Industrial Emissions Directive. The regulations promulgate Best Available Techniques (BATs) in each sector to manage water consumption and are overseen by the Environment Agency and local authorities. Data on the uptake of BATs is not systematically monitored.
- The Waste Resource Action Partnership (WRAP) Rippleffect scheme provides guidance to businesses on how to identify measures to save water and the benefits these measures provide. Since April 2013, 1,600 organisations have registered for the scheme. The NAP contains an action to continue to deliver the Rippleffect.
- The Federation House Commitment (FHC) provides support to help food and drink manufacturers reduce water use at their sites. It is a voluntary agreement that aims to contribute towards the food and drink industry target to reduce water use by 20% by 2020, relative to 2007 levels, as recommended in the Food Industry Sustainability Strategy. It currently has around 70 signatories with 278 sites, accounting for around one-quarter of water use by food and drink manufacturers. The NAP contains an action for WRAP to continue to deliver the scheme, although it now focusses on monitoring progress only rather than providing technical support.

Although other industries do not have industry-wide targets in place, there is evidence that some businesses are taking steps to minimise their water use. For example, a recent survey by the Chemical Industries Association (CIA) found that around one-half of its members had a water minimisation plan in place. Recent audits of paper mills by the Environment Agency also found some sites were monitoring water use comprehensively, with water re-use technologies in place to reduce overall abstraction. However, in some sites simple measures such as identifying and addressing leaks or turning off pumps and sprays were not being implemented.

Both direct abstraction from freshwater sources, and consumption of public water supplies by industry, have fallen by around one-quarter since 2000. This has been driven by a fall in production and improvements in water efficiency. Establishing a pricing framework that is more responsive to changes in water scarcity would help to incentivise further improvements in water efficiency in the future.

There has been a steady downward trend in consumption of public water supplies by non-residential customers since 2000, and a similar, albeit more volatile, trend in direct abstraction. In total, water use by industry was 700 billion litres (26%) lower in 2012 than in 2000.

The actions in the NAP have made a relatively modest contribution to the decline in water use. According to WRAP, the Rippleffect is estimated to have delivered savings of 2.5 billion litres in 2013/14. The latest report on the FHC showed that between 2007 and 2013 FHC signatories reduced their water use, excluding in products, by 16%.⁴⁴ This is equivalent to a reduction in water use of around 6 billion litres per year.

Improvements in water efficiency can be observed through changes in water intensity, which measures the volume of water used per unit of output produced. Estimating changes in this metric is challenging, as data on abstraction and production are not collected on a comparable basis. However, research for WRAP has identified a preliminary breakdown in water use by industry in 2006 that can be used to estimate the drivers of the recent changes in water use by industry.⁴⁵ Using this data, around one-third of the observed decline in water use can be attributed to a fall in production levels in large water using sectors. The remaining two-thirds of the decline can be attributed to improvements in water intensity, suggesting water intensity has fallen by around 20% since 2006. There are large uncertainties with this analysis, but evidence from the Federation House Commitment has found a similar change in water intensity in the food and drink manufacturing sector. This suggests water use is being actively managed by many businesses.

However, with abstraction reform on the horizon, businesses may need additional support to reduce water intensity further. Preparing the ground for abstraction reform, particularly in water-stressed catchments, will help make its introduction easier to accomplish and lessen the impact on business operations.

RECOMMENDATION 35: Defra should develop options in time for the next NAP, due in 2018, to encourage industry to improve water efficiency particularly in water stressed areas. This will help companies to make the transition to the likelihood of tighter restrictions and higher prices for water use during times of water scarcity, under abstraction reform.

⁴⁴ Hyder Consulting (2014) for WRAP *The Federation House Commitment progress report 2014*, <http://www.wrap.org.uk/content/federation-house-commitment>

⁴⁵ WRc (2011) for WRAP.

7.3.4. Business opportunities from climate change

Is there a plan?	 Green	The Government proposes to undertake research to better understand the size and composition of the adaptation goods and services market, and promote opportunities through existing policies. The Department for Culture, Media and Sport has a strategic framework in place for the tourism sector.
Are actions taking place?	 Green	The Greater London Authority (GLA) has undertaken research on the size and composition of the adaptation goods and services market. The ONS is conducting a feasibility study on behalf of Defra to develop a more comprehensive assessment. BIS and Defra have used existing evidence to identify priority sectors for “further action” in 2015/16, although these are not specified in their update against this NAP action.
Is progress being made in realising opportunities?	 Amber	UK companies have expertise in producing many types of adaptation goods and services. Sales have increased at faster rate than overall growth in the economy in recent years. However, UK sales growth has been slow compared to that of 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. Businesses can be expected to take advantage of these opportunities autonomously, as long as barriers do not exist.

Increases in the awareness and frequency of climate related events are likely to lead to a rise in the demand for adaptation goods and services both at home and abroad. The Climate Change Risk Assessment suggested higher temperatures may also make the UK a more popular tourist destination and increase demand for other goods and services, such as leisure activities.⁴⁶

Businesses in the UK may also benefit if they are less negatively affected by climate impacts than competitors in other countries. However, it is unclear to what extent this is likely to be the case and the international nature of many businesses in the UK means the net effect of any potential benefit is highly uncertain.

Businesses continuously adjust to changes in market conditions and can be expected to do so to take advantage of any opportunities that arise. In some cases, however, there may be a role for government policy in addressing potential barriers to growth.

The NAP contains a number of actions to promote and raise awareness of these potential opportunities. The actions primarily focus on the adaptation goods and services market.

Actions in the NAP focus on improving the evidence base on the size and composition of the adaptation goods and services sector, and promoting both domestic and international opportunities identified through this research. For example, Defra is exploring options with the Office for National Statistics (ONS) to run a feasibility study on markets for adaptation goods and services using internationally recognised survey methods. This could provide a more comprehensive view of the market if the pilot is successful and allow the Government to track developments in the market over time. Targeted studies on markets that are well defined, such as the water efficiency and flood products market, could add to the existing evidence base.

⁴⁶ Climate Change Risk Assessment (2012).

Defra is also working with BIS, the Environment Agency, and UK Trade and Investment (UKTI), to identify sectors that are best placed to take advantage of growth in adaptation goods and services and where government support may be required. The update to the NAP actions does not mention specific sectors, but highlights that further work will be undertaken in 2015/16. UKTI is continuing to promote exports of goods and services, which will include adaptation goods and services.

In 2010 the Department for Culture Media and Sport published its Strategic Framework for tourism. This sets out a number of actions that will be taken to increase the resilience of the sector to climate change risks and grow the visitor economy.

Qualitative and quantitative studies show businesses in the UK already have considerable expertise in producing adaptation goods and services. Sales of adaptation goods and services by UK businesses have grown in recent years, but appear to have lagged behind growth in sales amongst 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 for adaptation goods and services.⁴⁷ Qualitative assessments conducted by PwC and GHK have found the UK is already a key provider of adaptation goods and services in these sectors.^{48, 49} Previous analysis by the ASC has also shown 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 adaptation 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. 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.⁵⁰

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. This means there is uncertainty in the estimates of the size of the market based on publicly available data.

The data that are available suggest the UK is the seventh largest producer globally of adaptation goods and services, with sales of £2.1 - £6.1 billion in 2011/12.⁵¹ This is small when compared to the combined turnover of UK businesses of more than £3 trillion in 2011.⁵²

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.⁵³ Following advice from the ASC in 2014, the Environment Agency, with support from Defra, is undertaking a study to better understand the business opportunities from climate change and whether there may be barriers to growth. This should help to determine whether there is a case for government to intervene in the market for adaptation goods and services.

47 ASC (2014).

48 PwC (2013) *International threats and opportunities from climate change for the UK*, <http://www.pwc.co.uk/sustainability-climate-change/publications/international-threats-and-opportunities-of-climate-change-to-the-uk.html>

49 GHK (2010) for Defra *Opportunities for UK business from climate change adaptation*, <http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&ProjectID=17072&FromSearch=Y&Publisher=1&SearchText=GA0403&SortString=ProjectCode&SortOrder=Asc&Paging=10>

50 Grantham Research Institute (unpublished) *Invention and international diffusion of water conservation and availability technologies: evidence from patent data*.

51 K-Matrix (2013) for BIS *Adaptation and resilience to climate change (ARCC): Report for 2011/12*.

52 BIS (2011) *Business population estimates for the UK and regions 2012*, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/80247/bpe-2012-stats-release-4.pdf

53 ASC analysis of K-Matrix (2013) for BIS.

7.4 Conclusions on NAP objectives and actions

The table below summarises progress against the objectives listed within the NAP for the business theme. In general, the objectives describe a number of processes and list actions by which the resilience of businesses should be improved.

Of the 33 actions in the business chapter of the NAP:

- 12 (36%) are complete;
- 18 (55%) are on-track; and
- 1 (3%) has been revised.

Updates were not received on the remaining 2 (6%) actions.

Around a half (52%) of actions in the NAP for the business theme are time-bound, with the remainder classed as 'on-going'.

Table 7.1: NAP objectives and a summary of progress for the business theme	
NAP objective	Commentary on progress
Objective 23: To raise awareness and understanding amongst businesses about climate change risks.	There are nine actions for this objective. These actions focus on raising awareness and capacity through guidance, tools, training and professional standards. This includes an action for the Environment Agency to encourage businesses in high risk areas to undertake a flood risk assessment and register for flood warnings. All of the actions are complete or on-track. However, the low pro-active take-up of flood warnings in areas of high flood risk suggests many business still lack sufficient understanding of the risk of flood damage to their assets and operations.
Objective 24: To increase the extent to which businesses are actively considering climate change impacts, in their risk management and resilience planning and decision-making processes, and taking appropriate adaptive action.	There are eight actions for this objective. The actions are similar to those listed under Objective 23. This includes actions for the Environment Agency to promote risk management tools, such as the Business Resilience Health Check, and increase the number of firms using professional management standards to manage risks from climate change. There are actions for the Health and Safety Executive to review their workplace temperature guidance and for Defra to gather evidence on the size and structure of the adaptation market. Five (63%) of the actions are on-track and the remainder are complete. Businesses increasingly appear to be considering climate impacts in their risk assessments. However, there is little evidence of action being taken to reduce the physical risks from extreme weather, such as investing in property-level flood protection measures, particularly amongst SMEs.

Table 7.1: NAP objectives and a summary of progress for the business theme

NAP objective	Commentary on progress
Objective 25: To raise awareness and understanding amongst businesses about domestic and international climate change opportunities.	<p>There are ten actions for this objective, the most amongst the objectives in the business chapter. Four of the actions relate to Defra, Climate UK, UKTI and the Foreign & Commonwealth Office (FCO) raising awareness of the opportunities to businesses from the sale of adaptation goods and services. In addition, there is an action for the Greater London Authority to undertake a study to better understand the London adaptation economy.</p> <p>There are two actions to encourage the embedding of climate change adaptation in decisions by LEPs. The remaining actions relate to the FCO's work to continue to monitor of risks originating overseas and support their international negotiating strategy on climate change mitigation, and for the Green Investment Bank to consider climate resilience in its investment programme.</p> <p>Two of the actions on raising awareness of opportunities from the sale of adaptation goods and services have been revised to better define the coverage (in terms of domestic and international), and responsibilities between government departments.</p> <p>New research is likely to be adding to awareness and understanding of opportunities. Data on sales of adaptation goods and services suggest UK companies are taking advantage of their expertise in the market, but in recent years growth has been slower than amongst international competitors.</p>
Objective 26: To help businesses better understand and manage climate change risks to their supply chains.	<p>There are four actions for this objective. Three of these actions relate to the Environment Agency guidance on supply chain resilience. This includes publishing guidance, piloting it, and working specifically with small and medium sized businesses in the food and drink sector.</p> <p>The remaining action is for BIS to develop an industrial strategy which will provide confidence for investment and growth, and the development of resilient supply chains.</p> <p>Three of the actions have been completed. The pilot of the supply chains guidance has been delayed due to changes in company staff at Asda.</p> <p>Whilst support and guidance is available, only one-third of multi-national companies say they are actively managing supply chain risks arising from climate change.</p>
Objective 27: To undertake research to increase the understanding of climate change impacts on growth and the economy, working with investors, insurers and other industry partners.	<p>There are two actions for this objective. These actions focus on better understanding risks to the finance and insurance sector, and the links between adaptation and growth. These actions are reported as being completed, although no research documents have been published by Defra on these topics since the NAP was published. Later in 2015 the Prudential Regulatory Authority is due to publish its Adaptation Reporting Power report which will add to the evidence base for the insurance sector. There remain a number of gaps in understanding climate change risks to economic growth, particularly in relation to the finance sector.</p>



Chapter 8: Local government

- 8.1 Climate change and local government
- 8.2 Local government and the National Adaptation Programme
- 8.3 Progress with assessing climate change risks
- 8.4 Progress with climate sensitive functions
- 8.5 Conclusions on NAP objectives and actions



Key messages

Local authorities play pivotal roles in leading, supporting and driving the delivery of adaptation for their communities. Awareness of adaptation has improved significantly in recent years and the majority of local authorities have assessed the risks they face from climate change. A number of statutory requirements are helping to ensure that local authorities are taking action to reduce the vulnerability of their communities to climate change risks, even though these activities are generally not labelled as 'adaptation'. However, more could be done to further embed consideration of climate change into the delivery of these functions. Longer-term adaptation is a low political priority at a time of constrained budgets and more immediate pressures.

The local government chapter in the National Adaptation Programme (NAP) differs from the other six themes. It is a cross-cutting chapter, supporting the built environment, infrastructure, healthy and resilient communities, business and natural environment themes. For this reason, we have not identified separate adaptation priorities for local government, nor assessed progress using Red-Amber-Green ratings. Instead we review the progress being made by local authorities in assessing and strategically planning for climate change risks, and in delivering key climate-sensitive functions that are important for adaptation.

Summary of progress

The technical expertise of local authorities to assess the risks from climate change has improved significantly in recent years.

- Just over 70% of local authority respondents in a 2013 survey perceived their authority to be 'probably' or 'definitely well informed about climate change', compared to less than 20% in 2003.
- Nearly 80% of authorities surveyed in 2013 reported 'always' or 'sometimes' using climate information from the Met Office compared to 20% in 2003. The proportion always or sometimes using Environment Agency information doubled over the same period, from 40% to 80%.
- Compared to 2003, when over 40% of local authority respondents had not heard of the official UK climate projections, there is now near universal (92%) awareness. However, 38% of respondents describe UKCP09 as 'difficult' and 6% say they do not understand it at all.

Local authorities are applying their technical knowledge to assess climate risks. A high proportion have prepared adaptation strategies, but for a substantial number adaptation is not seen as a current priority at a time of constrained budgets.

- By 2010, 80% of local authorities in England had assessed climate risks to their localities and nearly half had reviewed the implications for their services. This was in response to central Government reporting requirements at the time under National Indicator 188 (NI188).
- In a survey of 90 local authorities conducted for the ASC this year, 42% had produced and published an adaptation strategy. A further 28% were either in the process of producing one or referred to an adaptation strategy at the County Council level. Nearly half of the published strategies had been produced since the abolition of NI188 in 2010.
- A substantial proportion of local authorities have reduced effort on adaptation. The reduction in local government spending since 2010 is likely to have had an impact on the priority given to adaptation. Around 90% of local authority staff interviewed in a 2013 survey stated that adaptation had been deprioritised in their authority.

- The main barrier to more widespread adaptation planning by local authorities is the over-riding need to respond to current economic and spending pressures. Climate change is often viewed as a long-term concern and not a current priority. The current focus tends to be on delivery of statutory duties, but there is no statutory requirement for local authorities to assess climate change risks or prepare adaptation strategies.

A number of functions being delivered by local authorities are helping to reduce the vulnerability of their communities to climate change risks, even though these activities are generally not labelled as 'adaptation'.

- **Land-use planning:** Consideration of future climate risks is embedded in land-use planning functions. In the survey of 90 local authorities, all Local Plans adopted after 2012 included policies on adaptation. All 90 authorities had undertaken strategic flood risk assessments, most of which accounted for climate change. Some urban authorities are proactively planning to increase green infrastructure, which can help to reduce the health impacts of the urban heat island effect.
- **Flood risk management:** Local authorities are producing local flood risk management strategies that account for how the risk of surface water flooding is likely to increase with climate change. However, as described in Chapter 2, progress in completing and agreeing local strategies has been slow.
- **Local infrastructure:** There is evidence of climate change risks being accounted for in local authority strategic transport planning.
- **Biodiversity protection:** The majority of local biodiversity plans sampled in the survey for the ASC explicitly accounted for the risks to the natural environment from future climate change.

However, more could be done to embed consideration of climate change risks into the delivery of other local authority functions important for adaptation.

- **Public health:** Climate-related risks, particularly from heat-stress and flooding, were not identified as a high priority in the majority of Joint Strategic Needs Assessments reviewed in our survey.
- **Emergency planning:** Very few emergency planning teams in local authorities in our survey are considering how flood risk may change in the future, or have plans for managing severe heatwaves.

Recommendation for further progress

RECOMMENDATION 36: Defra and DCLG should introduce a cost-effective and proportionate way of assessing the progress being made by local authorities in taking action to reduce the vulnerability of their communities to the impacts of extreme weather. This could be by including local authorities in the next round of the Adaptation Reporting Power.

Vision: “Local Government plays a central role in leading and supporting local places to become more resilient to a range of future risks and to be prepared for the opportunities from a changing climate.”

HM Government, 2013 National Adaptation Programme

8.1 Climate change and local government

Local government has a critical role to play in adaptation. With their democratic mandate, local authorities provide strategic leadership and are well placed to take a long-term view on shaping the future resilience of their communities. Local authorities also have statutory responsibilities for a number of ‘climate sensitive’ functions ranging from land-use planning, local transport and flood risk management, to public housing and social care.

Severe weather events are already putting pressure on councils and these can be expected to increase in frequency and intensity with climate change. Local councils are at the front-line when it comes to responding to and cleaning up after severe weather events, as was evident in the storms and flooding over the winter of 2013/14. The effectiveness of a local authority’s response to extreme weather events can often be a significant local political issue.

8.2 Local government and the National Adaptation Programme

The NAP dedicates a specific chapter to local government. This sets four objectives, focusing on raising awareness and building adaptive capacity.

- **Objective 28:** To raise and maintain the profile of adaptation with local authorities and promote action to embed climate resilience across local authority services and responsibilities.
- **Objective 29:** To support local government to build a credible business case for action and take well-informed decisions both internally across service areas and externally with their local communities and businesses.
- **Objective 30:** To ensure the policy framework for local government supports councils to increase community resilience in partnership with local and regional players.
- **Objective 31:** To support sector-led activities, which allow councils to make local commitments to address their own unique challenges and opportunities arising from changing climate.

A number of local authority functions are directly referred to in the thematic chapters in the NAP. These ‘climate-sensitive’ functions and associated NAP actions are summarised in Figure 8.1.

Figure 8.1: 'Climate-sensitive' local authority functions important for adaptation, and relevant NAP actions		
NAP theme	Local authority functions	Relevant NAP actions
Built environment	Land-use planning	<ul style="list-style-type: none"> • Implement National Planning Policy Framework • Promote uptake of green infrastructure
	Local flood risk management	<ul style="list-style-type: none"> • Produce and implement local flood risk management strategies
Infrastructure	Highways and local transport	<ul style="list-style-type: none"> • Build capacity and knowledge of local transport climate resilience
Healthy and resilient communities	Public health and social care	<ul style="list-style-type: none"> • Promotion of climate/severe weather preparedness within the health and social care system
	Emergency planning and response	<ul style="list-style-type: none"> • Build community resilience to extreme weather events and impacts of climate change
Natural environment	Local biodiversity planning	<ul style="list-style-type: none"> • Have regard to duty to protect biodiversity

This chapter is structured as follows:

- Section 8.3 reviews the progress being made by local authorities in assessing and strategically planning for climate change risks.
- Section 8.4 evaluates the progress being made in delivering the key climate-sensitive functions important for adaptation and the relevant NAP actions summarised in Figure 8.1.
- Section 8.5 provides a commentary on progress with each of the four objectives presented in the local government chapter of the NAP.

8.3 Progress with assessing climate change risks

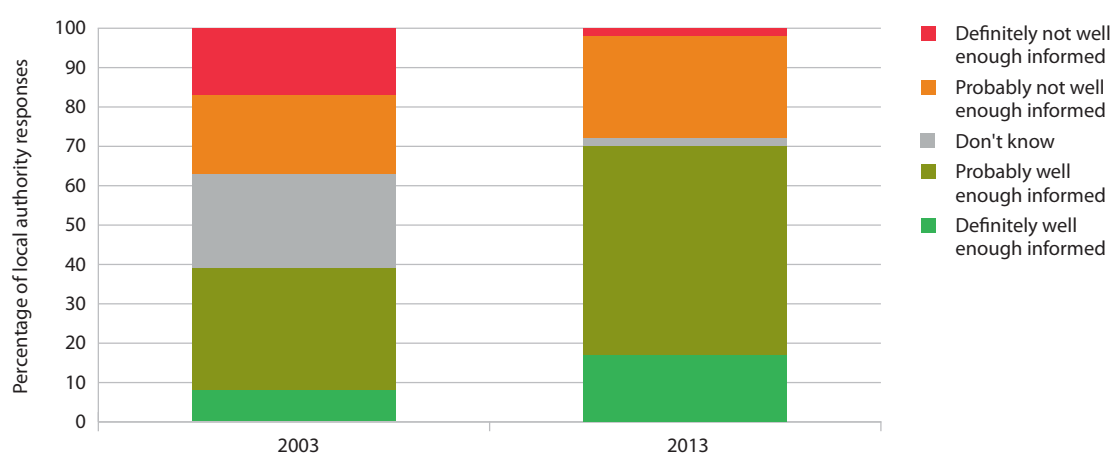
Awareness of climate change impacts, and the technical knowledge of local authorities on adaptation, has increased over the last decade.

A 2013 survey of 116 local authorities across the UK reported that many have developed their adaptive capacity since a similar survey was conducted in 2003.¹

- Just over 70% of respondents perceived their authority to be 'probably' or 'definitely well informed about climate change', compared to less than 20% in 2003 (Figure 8.2).
- Nearly 80% of authorities reported 'always' or 'sometimes' using climate information from the Met Office compared to 20% in 2003. The proportion always or sometimes using Environment Agency information doubled over the same period, from 40% to 80%.
- Compared to 2003, when over 40% of local authority respondents had not heard of the official UK climate projections, there is now near universal (92%) awareness. However, 38% of respondents describe UKCP09 as 'difficult' and 6% say they do not understand it at all.

¹ Porter, J, Demeritt, D. and Dessai, S. (2014) *The Right Stuff? Informing Adaptation to Climate Change in British Local Government*. Sustainability Research Institute, University of Leeds. Paper No. 76

Figure 8.2: Information available to local authorities in relation to climate change



Source: Porter et al (2014).

Notes: The research involved a longitudinal comparison of two datasets collected a decade apart. The first was a survey (n=184) conducted in 2003-04 with local authority environmental officers in England and Wales. The second survey was conducted online in November 2012, using many of the same open and closed Likert-scale questions as the 2003/04 survey to allow for a longitudinal comparison. It was addressed to chief environmental officers in all 407 local authorities in England, Scotland and Wales, of which 116 responded.

Local authorities have been applying their technical knowledge to assess the risks they face from climate change. By 2010, nearly 90% of local authorities had assessed climate change risks to their localities and nearly half had reviewed the implications of climate change for their services.

Between 2008 and 2010, local authority performance was assessed by central Government using the National Performance Framework and a set of national indicators. These indicators included NI188 which monitored progress in adapting to climate change. This indicator required local authorities to report how much progress had been made in assessing, and addressing, local climate change risks. NI188 defined four levels of progress in adaptation planning and implementation, against which local authorities assessed themselves.

By 2010, some 300 local authorities, nearly 90% of the total in England, had completed the comprehensive local assessment of climate change risks to reach Level 1 of NI188. Of these, around 150 (44% of total in England) had gone further by identifying risks to their services and functions (Level 2).

In the two years that NI188 existed, the rate of progress towards levels 3 and 4 was generally slow. Although 40 authorities progressed from level 0 to level 2, 82 reported no progress at all over the period. Less than 20 authorities assessed themselves as being at Level 3 (production of an action plan), and none at Level 4 (implementation).

Some local authority areas face greater climate change impacts than others. The majority of the 90 local authorities in those areas assessed as being at greatest risk have prepared, or are preparing, strategic adaptation plans.

In early 2015, the ASC commissioned a survey of 90 local authorities in areas facing the highest level of risk in the country from one or more climate change hazards.² This recognises that adapting to climate change is more important in some areas than others. The survey found that 38 (42%) of the highest risk authorities had published some form of climate change strategy or adaptation plan.

² The ASC reviewed 90 single (unitary) or lower (district) tier local authorities identified as being at the highest level of risk from one or more of the following climate hazards: river and coastal flooding, surface water flooding, heat stress, water scarcity, and coastal erosion. See JBA and LUC (2015) for the ASC *Research to survey local authority action on climate change adaptation*, <http://www.theccc.org.uk/publications/>

- 11 local authorities had a climate change strategy, which included adaptation actions.
- 12 local authorities had a stand-alone climate change adaptation strategy or action plan.
- 15 local authorities had both a climate change strategy and a separate adaptation strategy or action plan.

A further seven local authorities indicated that they were planning to develop a strategy or plan. If delivered, this would mean that half of the local authorities in the survey would have a plan in place.

An additional 18 local authorities referenced climate change strategies produced by the county council for the area. If these authorities are included, then 62% of the 90 local authority areas would have some form of climate change adaptation plan in place.

The 38 published climate change adaptation strategies were produced over a ten-year period between 2005 and 2014. Nearly half (47%) have been published since 2010. This suggests that adaptation activity amongst those local authorities facing the highest level of risk did not reduce after reporting against NI188 ended in 2010.

Amongst those surveyed, unitary authorities in urban areas were the most likely to have an adaptation strategy in place. Some 73% of the urban unitary authorities in the survey had an adaptation strategy. District councils in more rural areas are less likely to have produced an adaptation strategy. However, this may be because the relevant county council for the area has a strategy in place that covers the district council area.

The main types of actions in the adaptation strategies were to do with awareness raising and training for staff. Some specific measures included promoting the uptake of sustainable drainage systems (SuDS), water efficiency, passive cooling, and green infrastructure.

The survey deliberately focused on those local authorities facing the greatest climate change risks. Adaptation may be being prompted by current risks and historic episodes of severe weather. Other local authorities are likely to be less engaged in adaptation activity, particularly since the abolition of NI188. Evidence from other studies supports this, showing that adaptation activity since 2010 has been lower across all local authorities than suggested by the results of the survey conducted for the ASC.³

Budget constraints, competing priorities, and the lack of a statutory requirement, are the main institutional barriers to long-term adaptation planning amongst local authorities.

Local authorities in England lost 27% of their spending power between 2010/11 and 2015/16 in real terms.⁴ Some services, such as planning, have seen cumulative cuts in the order of 45% over the same period. There is evidence that this reduction has had an impact, particularly on non-statutory functions such as adaptation. For example, 90% of local authority staff interviewed in a 2013 survey stated that adaptation had been deprioritised in their authority.⁵ Half of those interviewed reported that climate change officers had been made redundant or there had been reductions in staffing levels.

The main barrier to strategic adaptation planning by local authorities is the overriding need to respond to other priorities, such as growing local economies and providing adult social care. Climate change is seen as a 'more distant and less immediate' societal threat than extreme weather, health-related emergencies, or travel disruption, which are given a higher priority in local authority corporate planning.⁶

³ See: Porter et al (2014) for references.

⁴ Joseph Roundtree Foundation (2015) *The Costs of the Cuts: The Impact on Local Government and Poorer Communities*, <http://www.jrf.org.uk/publications/cost-cuts-impact-local-government-and-poorer-communities>

⁵ Porter et al (2014).

⁶ *Ibid.*

Several respondents to the above survey also highlighted that the low priority was, in part, due to perceived 'mixed messages' from central Government on the importance of adaptation. This view was echoed by the Core Cities adaptation group in the update they provided to the ASC on the implementation of their actions in the NAP. The group argue that stronger leadership at the national level is required, and that support for adaptation has not been consistent across central Government departments.

The lack of a statutory requirement to consider and plan for adaptation was also identified as a barrier by 40% of local authorities in a 2014 survey for the Environment Agency.⁷ Feedback from local authority officers suggests councils are being forced to cut back services to the bare minimum in non-statutory areas. As climate change adaptation is not a statutory requirement, it is seen as highly vulnerable to further cuts.

Weather extremes remain a major concern for most authorities. Re-branding climate change adaptation as 'severe weather resilience' within local authorities may help to safeguard budgets. Data on the local costs of extreme weather events is improving. This will help support the business case for adaptation activity.

The effective management of extreme weather events is high on councillors' lists of concerns. Local authorities are a Category 1 responder to emergency events under the Civil Contingencies Act, and play a key role within Local Resilience Forums. Councils can be subject to significant reputational consequences if they are perceived to be taking insufficient action to support affected communities in response to events. Feedback from local authority officers working on adaptation suggests that their work gains more traction with councillors when they describe it in terms of increasing local resilience to severe weather events.

Some local authorities are beginning to collect robust data on the local costs of extreme weather events. This will help calculate the benefits of taking action to enhance resilience. For example, Kent County Council has developed a tool to identify the impact of severe weather on services, communities, reputation and the environment.⁸ This has identified that severe weather results in direct costs to Kent councils of around £44 million per year on average. The tool is now in the process of being rolled-out to other local authorities.

8.4 Progress with climate sensitive functions

8.4.1 Land-use planning and building control

Land-use planning and building control are two of the most important functions delivered by local government from an adaptation perspective.

Planning decisions can directly help to increase resilience to climate risks, but can also lock future generations into a development pathway that increases vulnerability, or one that will be very costly to maintain or reverse. By taking a strategic approach in their Local Plans, local authorities can:

- **Minimise flood risk.** In line with the National Planning Policy Framework (NPPF), local authorities should avoid inappropriate development in areas at risk of flooding. Where development is necessary, it should be made safe without increasing flood risk elsewhere. The NPPF also requires local authorities to prioritise the use of sustainable drainage systems in new development.

⁷ Brook Lyndhurst for the Environment Agency (unpublished) *Climate Change Adaptation in Local Authorities*.

⁸ See: <http://climateuk.net/resource/severe-weather-impacts-monitoring-system-swims>

- **Retain and enhance green infrastructure in built-up areas.** Green infrastructure includes measures such as green roofs, targeted urban tree planting, and constructed wetlands. Measures such as these are important for adaptation because they can help to keep cities cool in the summer and manage storm water during periods of heavy rainfall. According to the NPPF, local authorities should take a strategic approach to planning for the creation, protection, enhancement and management of networks of green infrastructure.
- **Address overheating risk.** New developments can be planned and designed to reduce the amount of heat entering or becoming trapped in a building. For example, factors affecting solar gain include the building's orientation, level of shading, size and design of windows, and ease of ventilation.

As well as planning for their own locality, local authorities are required under the NPPF to co-operate with their neighbouring authorities. This duty to co-operate is very important when considering strategic long-term planning in broad regions of the country where climate change is likely to have significant impacts, such as along stretches of coastline or in areas at high risk of water stress.

Only one-quarter of the highest risk local authorities have a 'legally sound' Local Plan steering the location and design of new development. However, almost all of the highest risk authorities are promoting climate change adaptation through local planning policies. Future flood risks have in almost all cases been assessed, but not all authorities are transparently identifying alternative sites outside the floodplain when making strategic allocations of land for development.

In the review of 90 local authorities for the ASC, 91% had an adopted Local Plan in place. This means the plan had been through a process of consultation and had been examined by a Planning Inspector at a public inquiry. The remaining local authorities had published draft plans that were going through the consultation or examination stage at the time of the review.

A total of 23 adopted plans had been approved after the publication of the National Planning Policy Framework in March 2012. This means that only one-quarter of the 90 local authorities have a 'legally sound' Local Plan that can be enforced (see Chapter 2: Built Environment). However, all of these 23 plans include local planning policies that promote climate change adaptation. This compares with 84% of the Local Plans that were adopted prior to the NPPF. In addition, 19 of the 90 local authorities have produced Supplementary Planning Documents specifically on climate change impacts. These primarily focus on flood risk, but around one-quarter also cover other risks such as heat stress, or reduced water availability.

All 90 local authorities in the review for the ASC had published Strategic Flood Risk Assessments (SFRAs). These inform the Local Plan by identifying flood risk areas within the local authority boundary. Most SFRAs (82 out of the 90) included climate change allowances for projected increases in river flows and sea level rise.

Local authorities are required to use SFRAs to inform decisions on allocating land for development in the Local Plan. In doing so, national planning policy requires local authorities to test alternative locations before deciding to allocate land for development in areas of flood risk (known as the 'sequential test' in planning policy). In the review for the ASC, not all authorities provided evidence of how the sequential test was applied. Nearly half (47%) of the Local Plans adopted before the NPPF did not explicitly apply the test. This had improved to some degree in post-NPPF Local Plans, with evidence of the test being applied in 15 of the 23 plans.

Some urban local authorities are proactively planning green infrastructure as an adaptation measure.

A relatively small proportion of urban local authorities (6 out of 55) surveyed by the ASC had prepared green infrastructure (GI) strategies. More than half (65%) of these strategies explicitly referred to the role that GI can play in adaptation, particularly highlighting natural flood management and passive cooling.

The absence of a dedicated GI strategy does not necessarily indicate that a local authority is not planning green infrastructure, as this may be covered in other documents such as local plans and flood risk management plans.

There is evidence that local authorities are requiring high levels of water efficiency in new homes through Building Regulations, but less evidence of the same stringency being applied for passive cooling measures.

Since 2010 Building Regulations have included a requirement for all new homes to be designed such that their calculated water use is no more than 125 litres per person per day. This is broadly the same as the average level of consumption per person in existing metered properties.

Some local authorities in their planning policies require more ambitious standards to be met. A 2014 survey of 109 local authorities for the Department of Communities and Local Government found over half (56%) required new development to be built to a Code for Sustainable Homes star rating of three or above, requiring a calculated water consumption of 110 litres per person per day or below. A further 9% of local authorities were imposing a different standard for water efficiency.⁹

Building Regulations do not set similar standards for measures to reduce the risk of buildings overheating. The risk of heat stress was recognised in only a very small minority of the 90 Local Plans reviewed in the ASC's survey. For example, only three of the 19 local authorities with supplementary planning guidance on climate change impacts addressed the risk of overheating.

8.4.2 Local flood risk management

Since 2010, county councils and unitary authorities have been given increased responsibility, powers and funding to manage local flood risk, in particular surface water flooding.

As noted in Chapter 2, widespread flooding across England in 2007 damaged 55,000 properties. The majority of properties were affected by surface water flooding, as heavy rainfall overwhelmed drains and sewers in urban areas. The independent Pitt Review¹⁰ that followed recommended that local authorities be given the lead role in managing local sources of flood risk. The review also recommended that local oversight and scrutiny committees be established to hold local partners to account for the steps being taken to alleviate local flood risks.

In response, the 2010 Flood and Water Management Act established 152 lead local flood authorities (LLFAs), the unitary or county council in each area. LLFAs were given statutory roles in the Act, and £36 million per year in funding from Defra, to prepare local flood risk management strategies, identify key flood management assets, and investigate flood incidents. New powers to support the work of local oversight and scrutiny committees were included in the Act.

⁹ EC Harris (2014) for the Department for Communities and Local Government *Housing Standards Review. Local authority policy survey*, http://www.gov.uk/government/uploads/system/uploads/attachment_data/file/353395/013_Survey_Write_Up_5th_August_2014.pdf

¹⁰ Sir Michael Pitt (2008) *Learning the lessons from the 2007 floods*, http://webarchive.nationalarchives.gov.uk/20100807034701/http://archive.cabinetoffice.gov.uk/pittreview/thepittreview/final_report.html

Nearly five years on from the 2010 Act, lead local flood authorities are making slow progress with preparing local flood risk strategies. The steps being taken by local partners are not being effectively scrutinised.

Whilst some of the new roles for LLFAs are statutory, the core task of managing and reducing flood risk is not. Even where statutory roles are specified in the Act, there is scope for LLFAs to determine the level of activity required to meet them. For example, local authorities are free to determine the scale of flood incidents that need to be investigated.

One third of local authorities responding to a Local Government Association (LGA) survey in 2012 said at least some of the funding provided by Defra had been allocated to other council services.¹¹ The Act did not set a deadline for the production of statutory summaries of the local flood risk management strategy. As a result, only five out of 152 LLFAs had published strategies by April 2013. This had increased to 24 by April 2014, but this still represents less than one-fifth of all LLFAs in England four years after the Act was passed.

There is also limited evidence of new flood risk management scrutiny committees being established, or existing scrutiny committees being tasked with this role.

In the review of 90 local authorities for the ASC, 37 (41%) had published Surface Water Management Plans. These are natural precursors for the statutory local flood risk management strategies required by the 2010 Act.

8.4.3. Highways and local transport

Local authorities appear to be considering climate change risks in strategic transport plans.

Local authorities are responsible for the construction and maintenance of non-trunk roads (representing 98% of all roads), as well as street lighting and bus shelters. They can therefore include increased resilience to extreme weather events in their capital and maintenance programmes where it is cost effective to do so.

Local authorities produce Local Transport Plans (LTPs). These are a statutory requirement, linked to the funding of major schemes. Some local authorities also produce dedicated highways or transport strategies. The third round of LTPs, which took effect from April 2011, will run until 2020.

In the review of 90 local authorities for the ASC, more than half (48) had a transport strategy. Almost all of these (41 out of the 48) have been published since 2011. All but one of the 48 plans explicitly referred to climate change risks. A high proportion included specific actions on adaptation, focusing on research, awareness raising, and training. Just under 40% of plans identified SuDS measures to improve the resilience of local transport networks to current and future flood risks.

8.4.4. Public health

Climate change risks only appear in one-fifth of the Joint Strategic Needs Assessments surveyed by the ASC.

The 2012 Health and Social Care Act introduced new public health functions for local authorities. Every county council and unitary local authority in England has a duty to take steps to improve the health of the people in its area. Local authorities are responsible for commissioning a range of services and initiatives to reduce excess deaths as a result of seasonal mortality. They are also required to manage

¹¹ Local Government Association (2012) *Flood risk management survey 2012*.

health protection incidents, disease outbreaks and emergencies, and reduce the public health impacts of environmental risks.

County councils and unitary authorities have a duty to prepare Joint Strategic Needs Assessments (JSNAs) and Joint Health and Wellbeing Strategies (JHWSs). JSNAs are assessments of the current and future health and social care needs of the local community, and are produced jointly with Clinical Commissioning Groups.

The Department of Health, the Sustainable Development Unit of the Health and Care System, Public Health England, and the Environment Agency, have produced joint guidance on integrating climate change adaptation into Joint Strategic Needs Assessments.¹²

Of the 50 unitary authorities in the survey conducted for the ASC, 48 had produced Joint Strategic Needs Assessments. Of these, 9 (19%) referred to the risk from heat stress increasing in the future with climate change. A similar proportion identified increasing flood risks.

Most of the actions in the JSNAs that mentioned climate risks related to flood incident management. The role that green infrastructure can play in minimising heat stress was also highlighted. However, there were no other measures identified to reduce heat stress risk, such as passive cooling measures (e.g. solar shading, enhanced ventilation) for new and existing buildings. There were also few examples of action being taken to identify vulnerable members of the community, such as the elderly.

8.4.5. Emergency planning and response

Flooding is by far the main climate change risk being planned for by local authorities. Very few local authorities appear to be considering how severe weather risks in general may change in the future.

The 2004 Civil Contingencies Act requires emergency responders in England and Wales to co-operate in maintaining a public Community Risk Register. These are approved and published by Local Resilience Forums (LRFs), established according to police force boundaries. LRFs include representatives from local emergency responders as well as public, private and voluntary organisations. Each local authority should publish its Community Risk Register on its website.

All local authorities, including county and district councils in two-tier areas, are expected to have emergency plans in place and implement these when required. In the survey for the ASC, 31 out of the 50 unitary authorities surveyed had made emergency plans or community risk registers publicly available. All of the 31 plans or registers referenced climate risks, with 27 out of the 31 mentioning flooding. Heat stress was identified by 12 (39%) plans or registers, and water stress by 9 (29%). Risks from severe weather events, in particular snow and wind, were also noted by 11 plans.

Although it is not a requirement, there was minimal reference in any of the 31 plans or risk registers to how these risks may alter with climate change. Objectives and actions in the plans all related to managing present-day risks, in particular through flood incident management, improved flood defences, and property-level flood protection. There were few objectives or actions that address the risks of heatwaves and drought.

¹² Department of Health, NHS, PHE, EA (2014) *Under the Weather: Improving Health, Wellbeing and Resilience in a Changing Climate*, www.climatechangenorthwest.co.uk/news/under-weather-adaptation-toolkit-health-and-wellbeing-boards

8.4.6. Local biodiversity action plans

Most local authorities are accounting for climate change when planning for the protection and enhancement of the natural environment.

Local Biodiversity Action Plans (LBAPs) identify priorities for action, and give guidance on implementing targets, to reverse historic losses of habitats and species. These plans are generally produced by county councils and unitary authorities rather than district councils. Local authorities also have responsibilities for managing parks, public gardens and other green spaces.

Councils can use these functions to:

- **Improve and extend ecological networks.** Local authorities can identify opportunities to extend and increase the connectivity of ecological networks so that species can adapt and move as the climate changes. Local authorities can also improve the ecological resilience of the green spaces they manage by growing trees and plants suitable for a changing climate.
- **Make space for water in urban areas, and along rivers and coasts.** Local authorities can alleviate flooding through the way they manage parks, the countryside, and other green spaces under their control.

In the review of 90 local authorities for the ASC, 50 had produced some form of biodiversity action plan or land use strategy.¹³ Of these, the majority (74%) referred to climate change risks to the natural environment. The main objectives in these plans and strategies related to green infrastructure, natural flood management, water efficiency, and use of SuDS.

8.5 Conclusions on NAP objectives and actions

The objectives within the local government chapter in the NAP focus on the sector playing a central role in leading and supporting local adaptation. There are a total of eight actions relating to the local government theme.¹⁴ Of these, six are classed as being on-track, and two have been delayed or revised. The updates received from the owners of these actions are provided in an annex to this report, available on the CCC's website.¹⁵

The responses from the owners of the actions demonstrate that there has been a significant effort to raise and maintain awareness and support local authorities on adaptation. Commentary on progress with each of the objectives is summarised in Table 8.1.

Table 8.1: Summary of progress for the Local Government objectives and actions in the NAP	
NAP objective	Commentary on progress
Objective 28: To raise and maintain the profile of adaptation with local authorities and promote action to embed climate resilience across local authority services and responsibilities.	<p>Defra established the Local Adaptation Advisory Panel (LAAP) to support the local government sector, working in close collaboration with the Environment Agency's Climate Ready service, the Local Government Association (LGA), and Climate UK.</p> <p>Since 2013, the LAAP has produced and disseminated material to local authority officers and councillors to highlight climate risks and the actions councils can take. Workshops and training have also been provided. The LAAP states that the actions in the NAP have been delivered but now need to be reviewed and made more challenging.</p>

¹³ JBA and LUC (2015) for the ASC

¹⁴ Note that a further 48 actions relevant to local government are also cross-referenced in the register of NAP actions.

¹⁵ See: www.theccc.org.uk/publications/

Table 8.1: Summary of progress for the Local Government objectives and actions in the NAP

NAP objective	Commentary on progress
Objective 29: To support local government to build a credible business case for action and take well-informed decisions both internally across service areas and externally with their local communities and businesses.	<p>The LAAP in collaboration with EA Climate Ready is overseeing the development of a local authority business case for action. This seeks to provide local councils with compelling evidence on the business case for adaptation.</p> <p>A series of products will be produced, incorporating high level messages, supported by a variety of data highlighting the financial and wider costs associated with severe weather events to council services. This will provide further evidence to support the need for upfront investment to secure long-term benefits for local communities and the environment.</p> <p>The NAP also includes an action for Climate UK to facilitate the roll-out of the Severe Weather Impacts Monitoring System (SWIMS), developed by Kent County Council. This action was reported as being on-track, but it is not clear from the update provided how many councils are developing or using SWIMS.</p>
Objective 30: To ensure the policy framework for local government supports councils to increase community resilience in partnership with local and regional players.	<p>The LAAP has sought to influence new central Government programmes and policies relevant to climate change resilience. LAAP Steering Group meetings provide an opportunity for local government representatives to provide direct feedback to government departments, and recommend how barriers and opportunities might be addressed. Meetings often involve government departments presenting emerging programmes and policies for discussion.</p>
Objective 31: To support sector-led activities, which allow councils to make local commitments to address their own unique challenges and opportunities arising from changing climate	<p>To date, 93 local authorities have signed up to the LGA's Climate Local initiative, making up just over one-quarter of all councils in England. Over 80% of signatories have produced detailed plans with over 1,400 specific actions.</p> <p>However, the majority of actions focus on activities to reduce emissions. Less than one-third (28%) of Climate Local actions focus on climate resilience measures. There are even fewer actions on specific risks, for example only 5% of actions are on flood resilience, and only 2% to improve water efficiency. Less than 1% of actions are health-related.</p> <p>The Core Cities Climate Change Adaptation and Resilience Working Group exists to provide a coherent voice on devolution policy in England in relation to adaptation, as well as to facilitate knowledge and information exchange, with the aim of furthering local adaptation action.</p>

Glossary

Adaptation

Adjustment of behaviour to limit harm, or exploit beneficial opportunities, arising from climate change.

Carbon dioxide (CO₂)

A greenhouse gas covered by the Kyoto Protocol.

Climate

The climate can be described simply as the 'average weather', typically taken over a period of 30 years. More rigorously, it is the statistical description of variables such as temperature, rainfall, snow cover, or any other property of the climate system.

Climate change

Climate change refers to a change in the state of the climate that can be identified (e.g. by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere, ocean or in land use.

Digital infrastructure

Information networks and technologies, fixed line and mobile telephony, data and application service providers.

Exposure

The extent to which a recipient (people, livelihoods, infrastructure, economic, social, cultural and environmental assets) comes into contact with a climate impact.

Fuel poverty

In the devolved administrations, a household is said to be in fuel poverty if it needs to spend more than 10% of its income on fuel to maintain an adequate level of warmth. England uses a low income, high cost (LIHC) definition that takes account of low incomes and higher than typical energy costs to define fuel poverty.

Greenhouse Gas (GHG)

Any atmospheric gas which absorbs thermal radiation emitted by the Earth's surface. This traps heat in the atmosphere and keeps the surface at a warmer temperature than would otherwise be possible.

Gross Domestic Product (GDP)

A measure of the total economic activity occurring in the UK.

Intergovernmental Panel on Climate Change

A scientific body under the auspices of the United Nations (UN) that reviews and assesses the most recent scientific, technical and socio-economic information produced worldwide relevant to the understanding of climate change.

Low-regret adaptation action

A measure that is cost-effective to implement today; where the benefits are less sensitive to precise projections about the future climate; and where there are co-benefits or no difficult trade-offs with other policy objectives.

Methane (CH₄)

Greenhouse gas covered by the Kyoto Protocol with a Global Warming Potential of 21 (1 tonne of methane emission corresponds to 21 tonnes CO₂e).

Mitigation

Action to limit the causes of climate change, principally by reducing sources (or enhancing sinks) of greenhouse gases.

Natural capital

Natural capital comprises assets associated with the land (such as woodlands, fields, urban parks and the subsoil), the water environment (rivers, lakes, groundwater and seas) and the atmosphere. It also includes the processes that underpin and generate the services that the natural environment provides (for example, the water cycle). The stock of natural capital therefore refers to assets that either directly provide benefits or underpin human wellbeing. In this way, natural capital generates value for society.

Nitrous oxide (N₂O)

Greenhouse gas with a global warming potential of 310 (1 tonne of nitrous oxide emission corresponds to 310 tonnes CO₂e).

Ofgem (Office of Gas and Electricity Markets)

The regulator for electricity and gas markets in Great Britain.

Office of Road and Rail (ORR)

The regulator for Britain's rail industry. From 1 April 2015 also the independent monitor of Highways England.

Ofwat (The Water Services Regulation Authority)

The economic regulator of the water sector in England and Wales.

Renewables

Energy resources derived from natural processes that are replenished constantly. They include geothermal, solar, wind, tide, wave, hydropower, biomass and biofuels.

Reshoring

The act of bringing outsourced personnel, services or production back to the United Kingdom from overseas.

Risk

Combines the likelihood that an event will occur with the magnitude of its outcome. Consequences may be defined according to the economic, social or environmental impact. Residual risk is the risk which remains after taking into account an adaptation action.

Soil degradation

Deterioration of soil due to human activity that leads to erosion of the soil and loss of nutrients or soil organic matter. This can be caused by agricultural activity and results in the soil losing its quality and productivity.

Standard Assessment Procedure (SAP)

The methodology used by the Government to assess and compare the energy and environmental performance of dwellings. It compares the energy performance of dwelling on a scale of 1 to 100, with 100 being the best performance.

State Aid

Where a company or sector receives government financial support that distorts competition or affects trade between EU member states.

Total factor productivity (TFP)

A measure of the efficiency of production. TFP is the growth in output which is unaccounted for by growth in inputs considered. Inputs include land, water for irrigation, fuel, fertiliser, seed, pesticides, capital and labour. Growth in TFP is generally driven by technological change, scale economies and switching to more productive agricultural activities.

Total expenditure ('totex')

The combination of operational expenditure ('opex') and capital expenditure ('capex').

Tillage

The preparation and cultivation of the soil or land for growing crop by ploughing, sowing and raising crops.

Uncertainty

A characteristic of a system or decision where the probabilities that certain outcomes will occur are not precisely known.

Vulnerability

The degree to which a recipient is affected, either positively or negatively, by exposure to a climate hazard. This includes the ability of the recipient to prepare, respond and recover from a climate hazard (and conversely to benefit from positive impacts).

Abbreviations

AD	Anaerobic Digestion
ADA	Association of Drainage Authorities
AIM	Abstraction Incentive Mechanism
AMP	Asset Management Plan
ARP	Adaptation Reporting Power
ASC	Adaptation Sub-Committee of the Committee on Climate Change
BIS	Department for Business, Innovation & Skills
CAP	Common Agricultural Policy
CCC	Committee on Climate Change
CCRA	Climate Change Risk Assessment
CCS	Carbon Capture and Storage
CDP	Carbon Disclosure Project
CFE	Campaign for Farmed Environment
CFP	Common Fisheries Policy
CH₄	Methane
CNI	Critical National Infrastructure
CO₂	Carbon dioxide
CO₂e	Carbon dioxide equivalent
DCLG	Department for Communities and Local Government
DECC	Department of Energy and Climate Change
Defra	Department for Environment, Food and Rural Affairs
DfT	Department for Transport
DOC	Dissolved Organic Carbon
EA	Environment Agency
EDW	Extended Direct (Flood) Warnings
ELS	Entry Level Scheme of Environmental Stewardship

EPSRC	The Engineering and Physical Sciences Research Council
ESIF	European Structural Investment Funds
EU	European Union
EWTP	England Woodland Timber Partnership
FAS	Farming Advisory Service
FCO	Foreign and Commonwealth Office
Fera	Food and Environment Research Agency (now part of Fera Science Limited and the Animal and Plant Health Agency)
FHC	Federation House Commitment
FWD	Flood Warnings Direct
GDP	Gross Domestic Product
GES	Good Ecological Status under the EU Water Framework Directive, or Good Environmental Status under the Marine Strategy Framework Directive
GHG	Greenhouse Gas
GIB	Green Investment Bank
GLA	Greater London Authority
GVA	Gross Value Added
HLS	Higher Level Scheme of Environmental Stewardship
HMG	HM Government
HMT	HM Treasury
HS2	High Speed 2
IDB	Internal Drainage Board
IEMA	Institute of Environmental Management and Assessment
IOAF	Infrastructure Operators' Adaptation Forum
ISO	International Organisation for Standardisation
IPCC	Intergovernmental Panel on Climate Change
ICT	Information and Communication Technology
IT	Information Technology

ITRC	Infrastructure Transitions Research Consortium
LA	Local Authority
LAAP	Local Adaptation Advisory Panel
LLFA	Lead Local Flood Authority
LEP	Local Enterprise Partnership
LRF	Local Resilience Forum
LTIS	Long-Term Investment Scenarios for flood and coastal risk management expenditure, produced by the Environment Agency.
MMO	Marine Management Organisation
MPA	Marine Protected Area
MPS	Marine Policy Statement
MSFD	Marine Strategy Framework Directive
NAP	National Adaptation Programme
NCC	Natural Capital Committee
NE	Natural England
NFU	National Farmers Union
NIA	Nature Improvement Area
NPPF	National Planning Policy Framework
NPS	National Policy Statement
Ofgem	Office of the Gas and Electricity Markets
Ofwat	The Water Services Regulation Authority
ORR	Office of Rail and Road
ONS	Office for National Statistics
PLP	Property-Level (Flood) Protection
PR14	Periodic Review 2014
R&D	Research and Development
RDPE	Rural Development Programme for England

RPI	Retail Prices Index
RSA	Restoring Sustainable Abstraction programme
SAC	Special Areas of Conservation
SAP	Standard Assessment Procedure
SFRA	Strategic Flood Risk Assessment
SMEs	Small and Medium Sized Enterprises
SOC	Soil Organic Carbon
SRA	Somerset Rivers Authority
SSSI	Site of Special Scientific Interest
SDU	Sustainable Development Unit
SuDS	Sustainable Drainage System
SPA	Special Protection Areas
TRaCCA	Tomorrow's Railway and Climate Change Adaptation
UK	United Kingdom
UKCP09	UK Climate Projections 2009
UKRN	UK Regulators Forum
UKTI	UK Trade and Investment
WFD	Water Framework Directive
WRMP	Water Resources Management Plan
WRAP	Waste and Resources Action Programme



Committee on Climate Change

7 Holbein Place
London
SW1W 8NR

www.theccc.org.uk

 **@theCCuk**